Sustainable Materials Management Plan

2015

City of Tacoma
WASHINGTON

CASCADIA
CONSULTING GROUP

Table of Contents

List of Tables

List of Figures

1. Introduction

Purpose

In May of 2014, the Tacoma City Council passed Resolution #38907 reaffirming the City's commitment to divert 70 percent of the city's solid waste by 2028. This goal was first articulated in the Tacoma-Pierce County Solid Waste Management Plan of 2008. The resolution also called for the development of a sustainable materials management plan "to ensure that the diversion goal of 70 percent or more by 2028 is met" and defined sustainable materials management as "an approach that includes waste prevention and discard management, while seeking to reduce environmental impacts by managing materials through all stages of their life."

This resolution supports the City's 2008 Climate Action Plan, which called for maximizing recycling, reuse, and waste minimization as a key component of the City's effort to reduce greenhouse gases. The resolution is also consistent with the City's long-standing commitment to stewardship as a guiding principle in achieving the vision of Tacoma as "an attractive and progressive international city, regarded for the richness of its diverse population and its natural setting" and the strategic goal of a "diverse, productive, and sustainable economy."

To develop this plan, the Office of Environmental Policy and Sustainability (OEPS) and Solid Waste Management, within Environmental Services (ES), commissioned a study of the current waste stream and recycling levels,[1] projections of future diversion levels under business as usual conditions, and an analysis of alternative options and strategies to achieve the 70 percent diversion goal. The plan development process included significant stakeholder engagement through interviews, forums, and workshops.

The City of Tacoma Sustainable Materials Management Plan consists of three volumes. This document is Volume 1 which presents the plan to achieve a minimum of 70 percent diversion by 2028 and to advance sustainability in Tacoma through minimizing waste and its impacts on the environment. Volume 2 contains the City of Tacoma *Waste Stream Composition Study* and Volume 3 is the City of Tacoma *Material Recovery Facility (MRF) Feasibility Study*.

Methodology

Tacoma's Office of Environmental Policy and Sustainability (OEPS) and Solid Waste Management, within Environmental Services (ES) commissioned the development of this sustainable materials management plan (SMMP) in 2015-2016, contracting with a consulting team led by Cascadia Consulting Group under the direction of staff.[2] The work to create the plan consisted of 10 interrelated studies, tasks, and activities:

[1] Key terms, such as *waste stream* and *recycling* are defined in the Glossary in Appendix 1.
[2] Key staff members included Jeanne Walter, James Parvey, Gary Kato, Lewis Griffith, Jetta Antonakos, Kristi Lynett, Andrew Torres, and Jeff Geforos.

1) **Characterizing the disposed waste stream.** Tacoma last analyzed the composition of its waste stream in 2009. As a foundation for developing the SMMP, Cascadia sampled waste from the City's residential, commercial, self-haul, and construction and demolition (C&D) streams to determine the composition of these streams and, in particular, the tonnage of recoverable materials that are currently being disposed. Results of this work are summarized in Section 3: Baseline Conditions and presented in detail in a separate report, *Volume 2: Waste Stream Composition Study*.
2) **Documenting current recovery levels**. The City routinely reports a recycling rate based on the materials that the Solid Waste Management (SWM) collects curbside from residents and businesses and from items dropped off at the transfer station. However, there are also private hauling businesses that collect recoverable materials and private operations like metals recovery depots that accept recoverable materials from the commercial and Construction and demolition (C&D) substreams. The recycling rate the City historically reported did not include quantities from private operations. Cascadia surveyed these private entities to ascertain the 2014 tonnage of recyclable materials they handle annually and combined survey results with the City's 2014 recycling rate data to develop a more complete estimate of current recycling and diversion levels. These findings are presented in Section 3: Baseline Conditions. In this plan, the term *recycling rate* is equivalent to diversion as defined by Washington State Department of Ecology; the rate includes municipal solid waste (MSW), plus recovered C&D and other materials, such as agricultural and industrial organics and materials managed through energy recovery.
3) **Conducting a Materials Recovery Facility (MRF) feasibility study.** One potential option for achieving the 70 percent goal is for the City to enhance capacity for recovering and processing recyclable materials, either by investing in its own MRF or by contracting with a private entity to build and operate one for city-collected materials. To determine the viability of this solution, J.R. Miller (with support from HDR, Cascadia, and Herrera) conducted a technical and financial feasibility study of four different MRF options. Results of this study are presented in a separate report, titled *Volume 3: Material Recovery Facility (MRF) Feasibility Study*, as well as incorporated into the analysis of options and strategies for the SMMP presented in Section 4: Recommended Strategies.
4) **Projecting baseline waste generation, diversion, and disposal estimates to 2048**. Using population and employment projections applied to per capita and employee waste generation, diversion, and disposal factors, *Cascadia projected the growth in the waste stream and diversion assuming business as usual, meaning no new City or private initiatives to reduce or divert waste*. These projections, presented in Section 3: Baseline Conditions, form the basis for quantifying the additional materials that need to be recovered from the waste stream over the next 12 years to meet or exceed the 70 percent target. Please refer to Appendix 4 for more detail on the projection calculations.

In this plan, the term *recycling rate* is equivalent to diversion as defined by Washington State Department of Ecology; the rate includes municipal solid waste (MSW), plus recovered C&D and other materials, such as agricultural and industrial organics and materials managed through energy recovery.

5) **Establishing SMMP goals, metrics, and targets.** While the goal of achieving a 70 percent diversion rate was clearly stated in the Council's resolution and the 2008 Tacoma-Pierce County Solid Waste Management Plan, the 70 percent goal needed more definition around what materials and waste substreams to include in the recycling rate calculation as well as what other metrics (such as per capita generation measuring the success of waste prevention efforts) to incorporate into the planning process. The *Standardized Data Collection and Reduction Goal Calculations* technical memorandum discussing alternative goals and metrics can be found in Appendix 2. Key approaches and metrics from that memo have been incorporated into the plan and this report.
6) **Defining and characterizing options to increase diversion.** Working closely with OEPS and SWM staff, the consultant team identified a comprehensive list of possible new education and outreach programs, incentives, regulations, investments, and changes to the collection and operations systems to increase recovery of selected materials from selected segments of the waste stream. Over 100 options were identified. Using the team's in-house database and expertise, as well as data from Tacoma, we estimated recovery rates and costs for each option. The City staff and consultant team ranked these options and then combined them into alternative strategies and scenarios to define alternative pathways to achieving 70 percent diversion. This analysis and results are also presented in Section 4: Recommended Strategies. The methodology is further described in Appendix 3. For a list of options considered, see Appendix 5.
7) **Building a diversion potential assessment model to conduct the options and scenario analysis**. A core element of the work to craft this plan involved creating a model to quantify the impacts and costs of alternative strategies, policies, and programs on Tacoma's waste stream. This model, developed by Herrera, calculated diversion rates and life cycle costs of each option and combination of options from 2016 to 2048 (see Appendix 3 for a more detail).
8) **Analyzing scenarios.** The consultant team created and analyzed four scenarios combining different options and strategies, as an interim step in developing a recommended set of actions, initiatives, and investments to achieve the City's goals.
9) **Engaging stakeholders.** Stakeholder input and buy-in is essential to the success of any plan, especially one with the ambitious goal of achieving a 70 percent recycling rate. Accordingly, the City's SMMP staff and the Cascadia Team involved stakeholders in several ways as part of developing the plan. Stakeholder engagement activities included:
    a. Interviewing 14 individuals at the outset of the planning effort on the current performance of Solid Waste Management, options they would like to see analyzed, and other relevant inputs to the plan. These individuals represented a range of internal and external constituencies, including the private substream, the County, environmental interests, and City Council.
    b. Hosting four workshops and forums; two with ES staff and two with the Sustainable Tacoma Commission (STC) to discuss options and scenarios and obtain input.
    c. Briefing the City Council Infrastructure, Planning, and Sustainability committee twice and obtaining input from Council members.
10) **Developing the plan.** The final task involved selecting a preferred strategy from the scenarios presented and then drafting the plan to both achieve the 70 percent goal and attain the broader sustainability goals embedded in the Council's resolution and be consistent with the mission and

vision of the City, the leadership of ES, and SWM and OEPS. The plan was developed in draft form, circulated for comment and feedback, and then revised accordingly.

Assumptions

At the outset of the planning process, the SWM and OEPS staff provided guidance on key assumptions and parameters to inform the scope, goals, viable options, and strategies in the plan:

1) The 70 percent diversion goal includes the diversion of municipal solid waste (MSW), construction and demolition (C&D) waste, and quantifiable waste prevention.
2) Hazardous, special, or universal waste streams are not included in the calculation of diversion.
3) The diversion goal only applies to waste generated within the boundaries of the City of Tacoma, regardless of the hauler or location of disposal.
4) The path to the 70 percent diversion goal should be phased with milestones and front-loaded to ensure the City is on track to meet the goal by 2028. This approach allows for adaptive management if earlier strategies do not perform as intended.
5) City staff, who participated in the workshop, were most interested in strategies with the highest diversion potential that consider the following issues and sub-goals as applicable:
    a. A life cycle perspective – with a focus on measuring full financial costs and qualitatively considering other life cycle impacts.
    b. C&D debris management – with additional goals and management issues (such as addressing the concern about lost revenues) to be addressed in the plan.
    c. Potential for increasing commercial and multifamily recycling rates.
    d. Consumption of disposable bags, bottles, and other products, which have a significant life cycle impact relative to their utility.
    e. A focus on Tacoma for upstream practices and material impacts – the City is primarily interested in policies that can reduce the amount of material generated in Tacoma and only secondarily interested in the impact of programs on the environment elsewhere.
6) Plans and options should be evaluated using a triple bottom line lens, rather than least cost.

2. Vision & Goals

Vision & Goals

The City of Tacoma's goal to achieve a 70 percent diversion rate by 2028 is part of a broader and more fundamental commitment to sustainability and "triple bottom line" outcomes. Tacoma's Environmental Services Department vision states that "we are national leaders that operate fiscally sound utilities, reducing our environmental footprint for the benefit of our community and future generations." ES's mission is to "provide sustainable and cost-effective management services to protect the environment, recover value from Tacoma's waste stream, and enhance the quality of life for the citizens and ratepayers." Finally, sustainability is one of six core values – along with safety, integrity, service, excellence, and innovation – that guide the ES's work.

Several guiding principles and considerations relate to the 70 percent goal and inform the development of the sustainable materials management plan:

1) The 70 percent goal by 2028 should be considered a "waypoint" towards a future where "waste" is recognized as a resource and its value is harvested.
2) Reducing waste, increasing recycling, and minimizing unnecessary consumption will all contribute to reducing greenhouse gas emissions and other adverse impacts on the environment. Reducing emissions is a paramount goal.
3) The plan should be based on life cycle thinking, where upstream and downstream costs and impacts associated with waste are considered. For example, benefits of recycling include reducing the adverse impacts of mining, transportation, and energy consumption associated with sourcing raw materials and turning them into packaging and products. The plan will consider full life cycle impacts while primarily focusing on reducing the amount of waste generated in Tacoma.
4) Achieving service and social equity are critical aspects of sustainability. All communities should have equal access to services such as recycling collection and waste prevention education, and over time, all communities should equitably benefit from these services.
5) The plan should be cost-effective, in keeping with fiscally sound operations, but not necessarily least cost. When considering least cost options, full life cycle costs should be analyzed to the extent practical, taking into account environmental and social costs and benefits as well.

The stakeholder interviews demonstrated broad support for the 70 percent goal and the vision of Tacoma as a leader in sustainable materials management. Most considered the goal a stretch, but achievable, and many emphasized that this goal should not be considered an end in and of itself but a milestone on a journey towards minimizing discards and turning waste into resources. Additional input from stakeholders regarding issues, barriers, and opportunities is detailed below. This input informed development of the plan.

Summary of Major Issues, Barriers, & Opportunities to Increased Diversion

During interviews and workshops, stakeholders expressed appreciation for the Solid Waste Management's services and strong performance. One stakeholder described the SWM as "efficient, well run, professional, and responsive to stakeholders." Many stakeholders complimented management and staff on their innovative, open-minded, and risk-taking approaches. Specific praise included:

- Efficiency and ease of use of the transfer station
- High quality recycling services and performance at the recycling center
- Excellent roll-out and implementation of every-other-week garbage collection
- Performance of the food and yard waste programs – the roll-out as well as the value of "turning food waste into gas"
- Effectiveness of the Solid Waste Division's community relations efforts, particularly the Knock & Talk campaigns

Stakeholders identified three areas where the City has room for improvement: 1) education and outreach; 2) diversion of food, fiber, and wood; and 3) increasing participation in diversion programs,

especially within the commercial, multifamily, and C&D substreams. Stakeholders urged the city to "act faster with more urgency" and to include market development and product stewardship in the toolkit to achieve the 70 percent goal by 2028.

Related to education and outreach, stakeholders cited the following as opportunities for improvement on the city's current programs:

- Do better at getting the message out about the benefits of recycling and how the system works; tell the story of recycling in a way that is engaging and brings people on board.
- Consider redesigning outreach collateral – some of the same collateral has been in use for many years and doesn't reflect current programs.
- Provide customers with feedback about how they are doing in terms of program participation.
- Provide more opportunities for face-to-face interaction between customers and outreach personnel.
- Invest more in communication with private substream partners.

Related to diversion of food, fiber, and wood, stakeholders offered that the City of Tacoma should expand food waste collection to include other compostables like food-soiled paper and untreated wood.

Related to increasing participation in diversion programs, stakeholders reaffirmed that the commercial, multifamily, and C&D substreams are particular areas of opportunity. Specifically, the C&D substream is "kind of an unknown" in terms of the scope of opportunity, and banning C&D disposal may be the best way to enhance diversion in that substream, provided that there are facilities that can successfully process and divert C&D materials.

To get to 70 percent diversion from the landfill, stakeholders generally favored incentives and not mandates, though they recognized the value and efficacy of selected mandates in certain circumstances. They did not want to jeopardize customer goodwill and strong customer satisfaction, particularly among single-family residents. However, if mandates are needed to reach 70 percent, stakeholders recommended that there be a robust plan, long lead time, and extensive education prior to implementation. Many stakeholders expressed the opinion that they prefer mandatory recycling to bans, and all stakeholders urged that any mandates, if implemented, be uniformly enforced. Support for a plastic bag ban was mixed. Stakeholders said that they see rate incentives as a means of encouraging good customer choices through a price signal, with one stakeholder commenting: "Absolutely, increasing costs will drive diversion."

Other input received from stakeholders included:

- Be sure to involve the public – as soon and as much as possible – in both the planning and implementation processes.
- Expand education at events and continue Knock & Talk campaigns to fully engage the public in implementation.
- Consider partnering with private recyclers on education and outreach, processing, and market development.
- Make sure that the plan and its programs are data-driven and that the plan is innovative in developing new markets to enable the success of recycling new and different materials.

Key Metrics

Tacoma's definition of a recycling rate includes mixed solid waste (MSW) and other diverted materials, including construction & demolition (C&D) waste, and is equal to total recovery divided by total generation citywide and by substream of these materials. This rate is comparable to Washington State's annually reported diversion rate. Other key metrics used to measure Tacoma's performance include:

- **Per capita generation**: equal to citywide generation divided by population to measure trends that are normalized for population and employment growth over time.
- **Recoverability potential**: the percentage and tons of waste that could have been recycled or composted, in total and by substream.
- **Capture rates:** for key recyclable and compostable materials overall and for selected substreams. Capture rate is defined as the total tons of recyclables collected in recycling programs divided by the total tons of recyclables collected in recycling programs and disposed.

3. Baseline Conditions

This section provides an overview of the composition of the existing waste stream, the recovery potential in that stream, current recycling and capture rates, and existing diversion programs. The figures presented in this section are a combination of disposal, recycling, and composting tonnages from 2014, and composition study results from 2015. Cascadia collected the 2014 tonnages through a survey of Tacoma's records and of private haulers and processors collecting materials from the City of Tacoma. The 2015 composition study is one that Cascadia completed to fulfill Task 1 of its contract with the City of Tacoma. The study included an examination of the City's disposed waste and organics material streams.

All of the data presented in this section is intended to serve as the foundation for building a targeted, effective plan to support the City of Tacoma as they work towards reaching 70% diversion by 2028. Having up-to-date, accurate data to support this planning is essential for ensuring that the plan is well-informed and suggests realistic steps for achieving the city's goals.

Summary of Current Diversion Programs and Activities

The City of Tacoma has many successful current programs and activities to support diversion in the city. A sampling of these programs and activities include:

- **Curbside collection of commingled recyclables.** The City of Tacoma's Solid Waste Management (SWM) provides single-family generators with separate carts for garbage, commingled recyclable materials, recyclable glass (may be commingled in the future), and yard debris. Recycling collection services for single-family residents are voluntary, but in 2014, about 97% of residences participated in the recycling collection program.

  Tacoma offers the same voluntary curbside collection services to tri-plexes and four-plexes. Larger multifamily sites have also expressed interest in a curbside commingled recyclables

collection program, and Tacoma designs and implements programs for these larger sites as requested.

Commercial customers also have voluntary access to collection services for glass and commingled recyclables. Commercial customers can subscribe to recycling collection services with private recycling companies for recyclables such as cardboard and mixed paper.

- **Processing of commingled recyclables.** The City of Tacoma's recyclables go to Waste Management's JMK material recovery facility (MRF) for processing. WM retrofitted the existing MRF with updated technology and added a glass removal system and reopened the facility in 2013. Given these improvements, WM informed Tacoma's SWM that collecting glass separately was no longer necessary. However, SWM continued to collect glass separately: they have a well-established two-stream collection system with high participation rates and customers have grown accustomed to separating glass. Also, SWM had concerns that commingling the glass with the rest of the recycling stream could contaminate the commingled stream and impact commodity values. Tacoma's glass is hauled to JMK's facility and then transferred to Strategic Materials in Seattle for recycling.
- **Food and yard waste (Organics) collection programs.** The city recognizes that food and yard waste make up a significant portion of the waste stream. They offer curbside collection for these materials at no additional charge for residents, and at a subsidized rate for commercial customers. The curbside program roll-out was widely recognized as successful; the city received a 2013 SWANA Gold Excellence Award in Communication for its food waste program community outreach efforts. This roll-out included door-to-door Knock & Talk messaging that focused on what materials are acceptable in the program, how to make participating in the program simple, and tips to avoid odors and pests.
- **Tacoma Recovery and Transfer Center operations.** The Tacoma Recovery and Transfer Center (TRTC) offers a variety of diversion services all in one place. The Tacoma Recycling Center operates within the Tacoma Recovery and Transfer Center, and accepts self-hauled materials including metal items, glass bottles, plastics, cardboard and paper, batteries, electronics, among other difficult-to-handle materials like used motor oil and packing peanuts. The Recycling Center also accepts recyclables that the city's municipal collection system picks up curbside. Goodwill has a semi-permanent presence at the center, accepting unwanted clothing and household items. Center employees working at the garbage dumping floor survey incoming materials and hand remove materials that can be diverted, an effort that has resulted in significant diversion results. The center also features the EnviroHouse that teaches visitors about sustainable behaviors that they can adopt at home.
- **Every-other-week single-family garbage collection.** The City of Tacoma has offered every other week collection to their residents since March 2013. This collection service amendment, intended to reduce costs for the municipal collection service and increase waste diversion for the city, has demonstrated results. In the first quarter of the program, the city's municipal collection system reduced fuel costs by 44 percent, and carbon dioxide emissions by 20 percent.[3]

[3] http://www.cityoftacoma.org/cms/One.aspx?portalId=169&pageId=63053

- **Knock & talk outreach.** The city has used this approach for the launch of new programs such as the every-other-week collection. This approach, which has proved effective, involves going door-to-door to customers to explain the new program and answer any questions. This Knock & Talk outreach strategy played a large role in making every-other-week collection a success in the city by giving residents personalized assistance to make sure they had the right garbage collection infrastructure to make the program work for them.

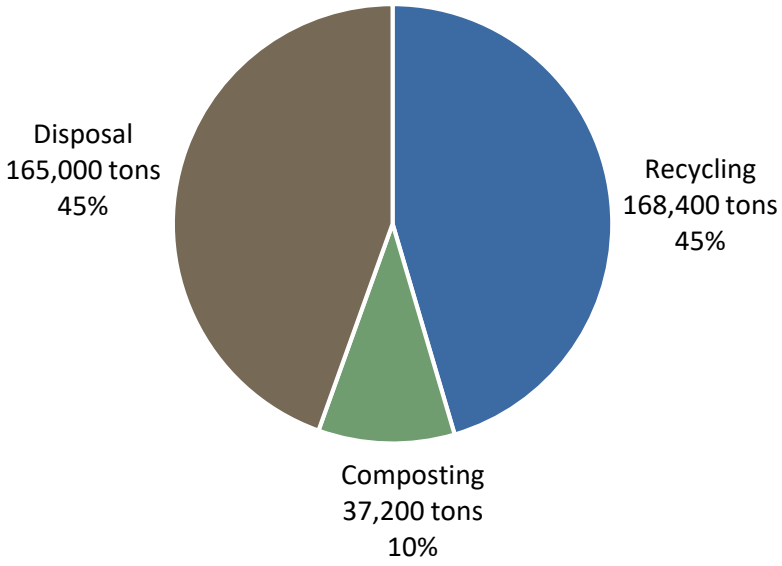
Overall Generation

Figure 1 below is a representation of overall generation for the City of Tacoma in 2014, divided by materials disposed, recycled, and composted. For the purposes of this study, generation is defined as the sum of materials from Tacoma that are disposed in the landfill, processed for recycling, and sent to composting facilities. Of the 370,500 tons of material generated in 2014, 55 percent of the material was recovered for recycling or composting.

Figure 1 also presents estimated capture rates for the recyclables and organics generated in Tacoma. A recycling capture rate compares the tons of recyclable materials being recycled to the sum of the tons of recyclable materials recycled and the tons of recyclables materials disposed. Capture rate is defined as the total tons of recyclables collected in recycling programs divided by the total tons of recyclables collected in recycling programs and disposed. For example, if 80 out of 100 tons of recyclables generated in Tacoma were recycled, the capture rate would be 80%.

In Tacoma in 2014, the estimated capture rate for recyclables was 73 percent, and the estimated capture rate for organics was 44 percent.

Figure 1. 2014 Overall Generation and Recovery Profile

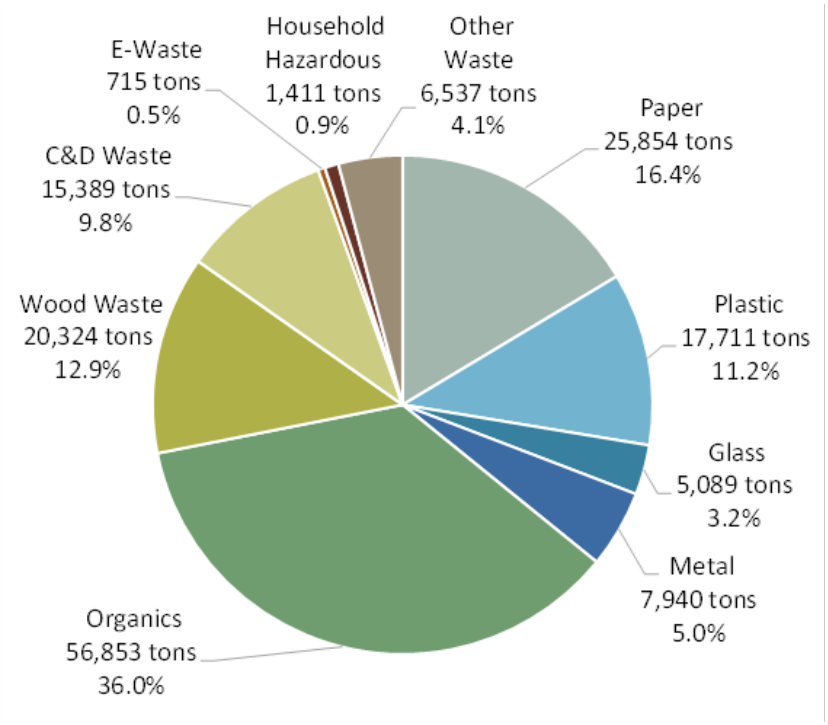


Waste Disposal by Material Class

Figure 2 below presents the composition of the waste that Tacoma disposed in 2014 by material class. These composition estimates are based on the waste characterization study that Cascadia completed in 2015. For sorting purposes, the study established 85 standard material types for the waste stream. These material types were organized into ten material classes: **Paper, Plastic, Glass, Metal, Organics, Wood, Construction Materials, E-Waste, Household Hazardous/Special Waste,** and **Other.** For example, the *newspaper* material type is categorized in the **Paper** material class.

The two most prevalent material classes in the disposed waste stream are **Organics** (36.0%) and **Paper** (16.4%), making up more than one-half of all disposed waste. Many of the materials in these two classes are recoverable (depending on the health of local and global markets) and represent significant opportunities for increased diversion through expanded recycling and composting programs.

Figure 2. 2014 Overall Waste Disposal by Material Class (165,000 tons)

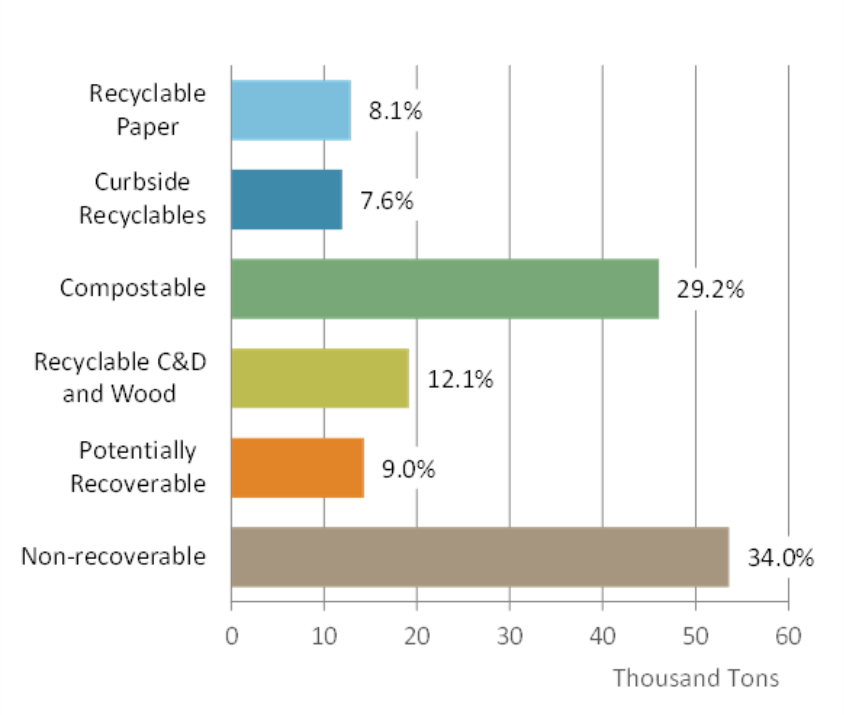


Waste Disposal by Recoverability Class

Figure 3 below presents the composition of the waste that Tacoma disposed in 2014 by recoverability class. The waste characterization study that Tacoma completed in 2015 defined six recoverability categories: Recyclable Paper, Curbside Recyclables, Compostable, Recyclable C&D and Wood, Potentially Recoverable, and Non-Recoverable. Material types were assigned to recoverability categories based on the availability of recycling or composting opportunities in the Puget Sound area.

Other than the Non-recoverable (34.0%) portion, the most prevalent recoverability classes were Compostable (29.2%) and Recyclable C&D and Wood (12.1%).

Figure 3. Recoverability of Overall Disposed Waste, 2014



Waste Disposal and Recoverability by Substream

Figure 4 below presents 2014 Tacoma waste disposal by substream. For the purposes of this report, "substreams" are essentially types of generators. This study divided Tacoma's disposed waste stream into five substreams— single-family, multifamily, commercial, self-haul, and C&D.

Disposal is defined as the tons of material received at the Tacoma Recovery and Transfer Center and sent to the landfill. Generators in the commercial substream disposed the most waste in 2014; they were responsible for 37 percent of waste disposed in 2014. The single-family and self-haul substreams were each responsible for 20 percent of the waste disposed. The multifamily substream was responsible for the least amount of material disposed in 2014, at 8 percent of the total.

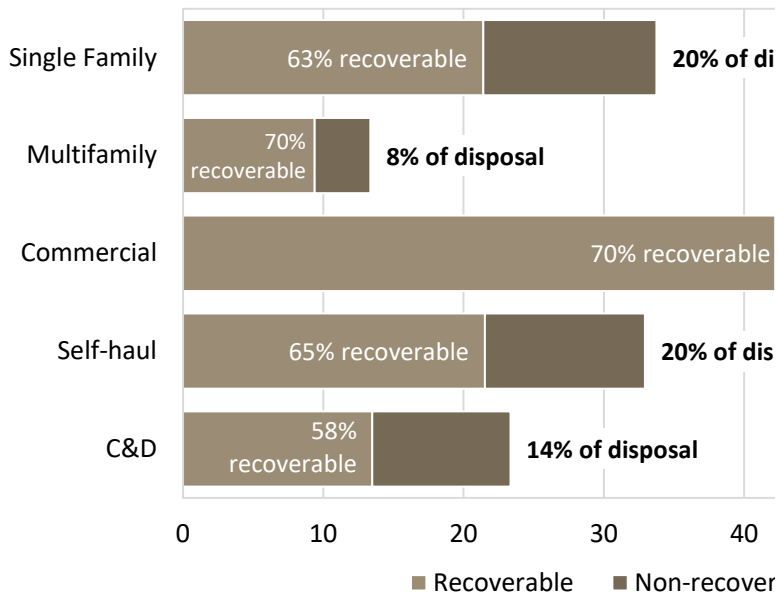
Figure 6 below also presents the portion of recoverable waste disposed by substream Recoverability is defined as materials that could be diverted through Tacoma's current recycling and composting programs. As **Figure 6** demonstrates, the commercial and multifamily disposed waste stream were equally recoverable (70 percent of the disposed material in each substream was estimated to be recoverable). However, the commercial substream's disposed waste represents the most significant opportunity for recoverable materials, with about 43,029 tons of recoverable material disposed in 2014. This is more than double the opportunity for material recovery in the disposed waste for any other substream.

Disposed waste for the single-family and self-haul substreams also represented significant opportunities for increasing diversion. The single-family substream's disposed waste was 63 percent recoverable (an opportunity of about 21,397 tons), and the self-hauled substream's disposed waste was 65 percent recoverable (an opportunity of about 21,525 tons).

For the purposes of this report, "substreams" are essentially types of generators. This study divided Tacoma's disposed waste stream into five substreams— single-family, multifamily, commercial, self-haul, and C&D.

The commercial substream's disposed waste represents the most significant opportunity for recoverable materials, with about 43,029 tons of recoverable material disposed in 2014. This is more than double the opportunity for material recovery in the disposed waste for any other substream.

Figure 4. Waste Disposal and Recoverability by Substream, 2014



Cascadia calculated the City of Tacoma's 2014 recycling rate by considering recycling from two sources: tons of recyclables managed by the city's municipal system and tons of recyclables managed by private haulers and processors.

Recycling and Capture Rates

Cascadia calculated the City of Tacoma's 2014 recycling rate by considering recycling from two sources: tons of recyclables managed by the city's municipal system and tons of recyclables managed by private haulers and processors. Previous recycling rate calculations had only considered tons managed by the municipal system, and therefore underestimated the city's recycling rate, both overall and for the commercial and C&D substreams in particular. For the purposes of this analysis, the term "recycling rate" includes all activities that the Washington State Department of Ecology (Ecology) defines as recycling, including materials that are composted, as well as all of the activities that the Ecology defines as diversion.

For the purposes of this analysis, the term "recycling rate" includes all activities that the Washington State Department of Ecology (Ecology) defines as recycling, including materials that are composted, as well as all of the activities that the Ecology defines as diversion.

In 2014, Tacoma achieved a 41 percent recycling rate (excluding C&D) for residential and commercial waste and a 55 percent recycling rate overall when C&D debris is included.

To calculate this recycling rate, we compared the amount of recoverable materials being recycled to the total amount of wastes that are generated (all materials that are recycled and disposed). We used the following equation to accomplish this:

$$recycling\ rate = \frac{total\ tons\ of\ recoverable\ material\ collected}{total\ tons\ of\ recoverable\ materials\ collected + total\ tons\ of\ garbage\ collected}$$

Cascadia collected information about the tonnage of recyclables managed by private haulers and processors by working with the City of Tacoma to survey these haulers and processors. The city and Cascadia identified 24 private haulers and processors that handle recyclables generated within the city

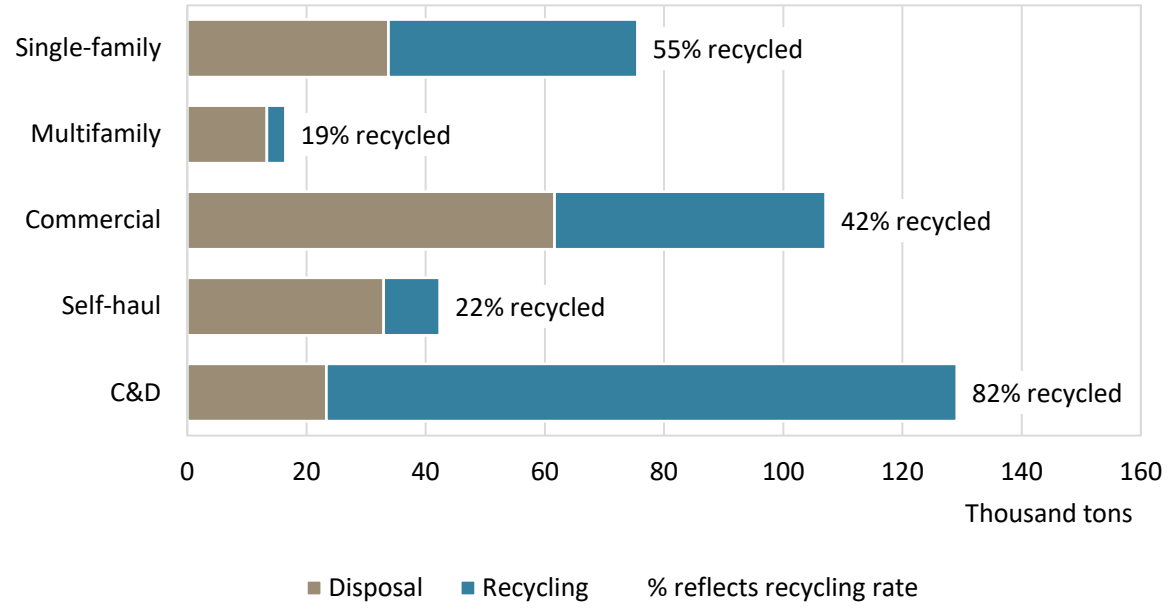
of Tacoma and outside of Tacoma's municipal collection system. Cascadia obtained data from 12 of these companies on tons of commercial, self-haul, and C&D debris materials recycled.

These additional tons substantially increased the commercial and C&D debris recycling rates, and boosted overall recycling rates as well. In 2014, Tacoma achieved a 41 percent recycling rate (excluding C&D) for residential and commercial waste and a 55 percent recycling rate overall when C&D debris is included.

The C&D substream recycling rate is the highest among the substreams, at 82 percent, followed by the single-family substream at 55 percent.

Figure 5 below provides more detail about the City of Tacoma's recycling rate for each substream. The C&D substream recycling rate is the highest among the substreams, at 82 percent, followed by the single-family substream at 55 percent.

Figure 5. Waste Disposal and Recycling by Substream, 2014



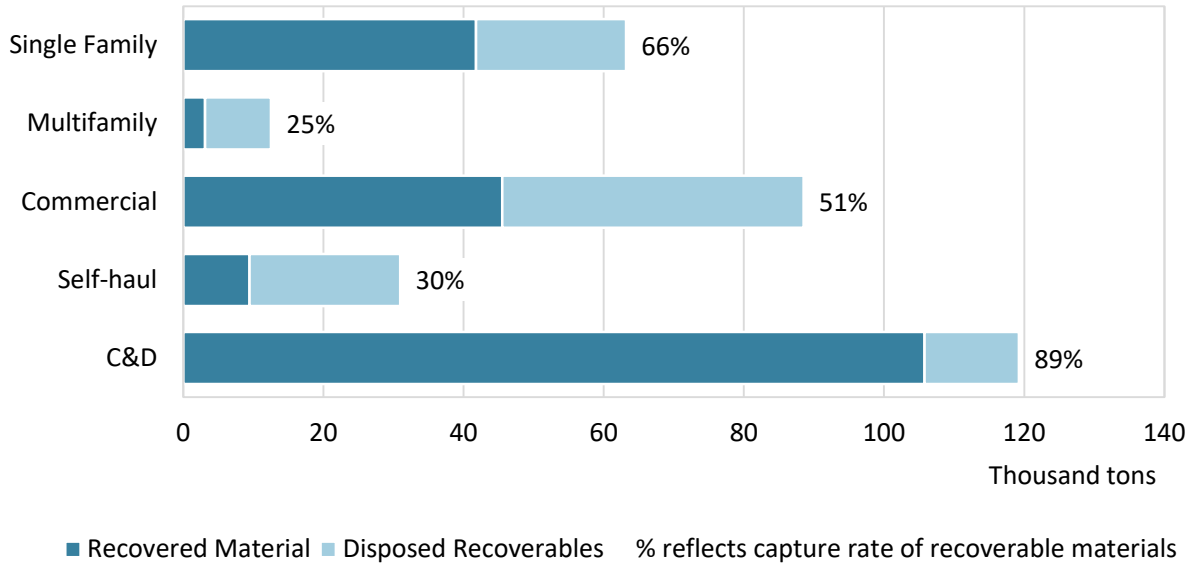
Capture Rates by Substream

Figure 6 demonstrates the capture rate of recoverable materials by substream. As discussed above, we calculated capture rates by comparing the tons of materials that are recovered to the sum of the tons of materials that are recovered and the tons of materials that are disposed in the garbage**.** The C&D substream has the highest capture rate of all of the substreams: 89 percent of recoverable materials that the substream generates are recovered. By contrast, the multifamily substream has the lowest capture rate: 25 percent of recoverable materials that the substream generates are recovered.

As discussed above, the most significant opportunities for recovering additional materials are in the commercial (43,029 tons of recoverable materials disposed in 2014), self-haul (21,525 tons of recoverable materials disposed in 2014), and single-family (21,397 tons of recoverable materials disposed in 2014) substreams.

The C&D substream has the highest capture rate of all of the substreams: 89 percent of recoverable materials that the substream generates are recovered.

Figure 6. Capture Rates of Recoverable Materials by Substream, 2014



Per Capita Normalized Generation Rates

The normalized generation rate for Tacoma in 2014 is a function of the number of tons of material generated, divided by the total population. In 2014, Tacoma generated 370,520 tons of material, and had a population of 200,900 people. Dividing population by generation yields a per capita annual generation rate of 1.84 tons of material per person.

In 2014, Tacoma generated 370,520 tons of material, and had a population of 200,900 people, which is equivalent to a per capita annual generation rate of 1.84 tons of material per person.

Baseline Projections

As part of the planning process, Cascadia projected the growth in generation, diversion, and disposal through 2028 assuming business as usual, meaning no new City or private initiatives to reduce or divert waste. Business as usual is described in Section 3, above. This assumption included the supposition that diversion results from these current diversion programs and activities would also stay the same over time.

Generation, Disposal, Diversion to 2028

Cascadia estimated growth in the waste stream through 2048 by multiplying per capita, per household, and per employee waste generation by the relevant projections for each generator group. These projections, presented at the summary level in this section, define the additional tons that need to be recovered from the waste stream over the next 12 years to meet or exceed 70 percent diversion by 2028.

The specific data types and sources that Cascadia used to calculate these projections are shown in **Table 1** below.

Table 1. Data Sources for Generation Projections, by Generator Group

Generator Group	Data Type	Source
Residential Self-Haul	Total Population	Office of Financial Management
Single-Family	Single-family households	Puget Sound Regional Council
Multifamily	Multifamily households	Puget Sound Regional Council
Commercial/Commercial Self-Haul	Total employment	Employment Security Department
Construction and Demolition	Construction employment	Employment Security Department

Cascadia allocated total waste generation for future years to disposal, recycling, and organics streams based on 2014 recycling and composting rates for each substream. The 2014 data sources included: the recycling survey described in the Recycling and Capture Rate section (in which Cascadia surveyed 12 private haulers and processors that handle recyclables generated within the city of Tacoma and outside of Tacoma's municipal collection system about the tons of material they recycle); and the recycling and composition data that the City of Tacoma consistently tracks and reports on. Cascadia split the City of Tacoma data into substreams—such as single-family and multifamily—based on Tacoma recycling data, Seattle recycling data, and 2015 Tacoma waste composition data.

Total Recovery and Disposed Tons MSW and C&D

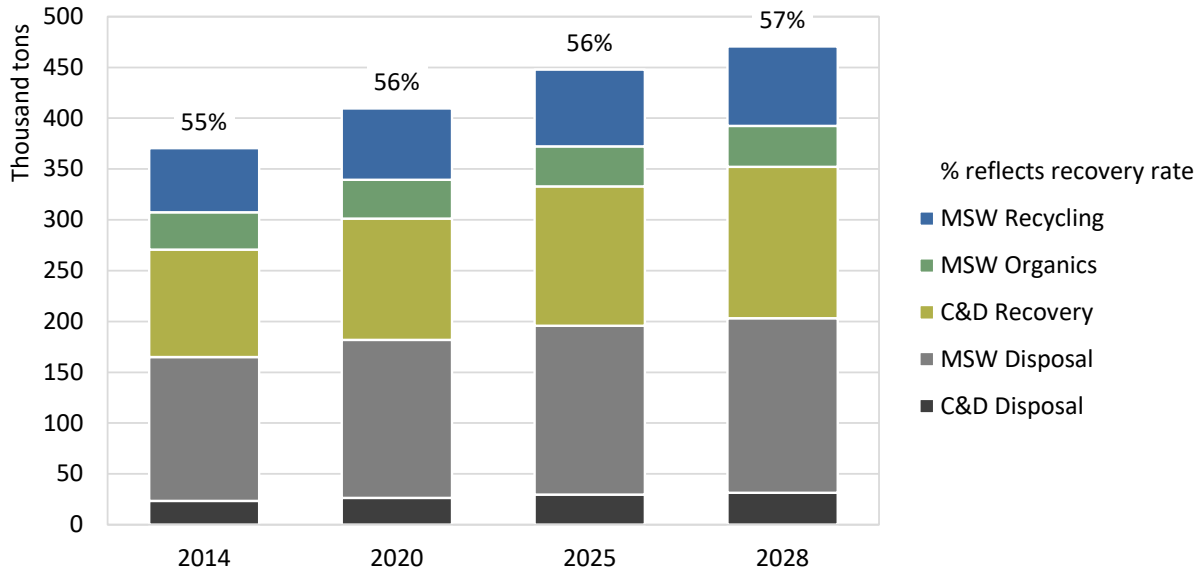
Figure 7 below provides projected total recovery and disposal tons. The column representing 2014 is based on actual data collected for this plan, and the 2020, 2025, and 2028 columns are projections. Between 2014 and 2028, overall recovery is projected to increase by about 61,900 tons; and overall disposal is projected to increase by about 38,100 tons in the same time period.

C&D Recovery is expected to increase substantially (by 43,406 tons), as is MSW Disposal (projected to increase by 30,176 tons). MSW Recycling is also projected to increase, by an estimated 15,000 tons. The smallest changes are expected for MSW Organics (projected increase of 3,484 tons) and C&D Disposal (projected increase of 7,932 tons).

C&D Recovery is expected to increase substantially (by 43,406 tons), as is MSW Disposal (projected to increase by 30,176 tons).

The smallest changes are expected for MSW Organics (projected increase of 3,484 tons) and C&D Disposal (projected increase of 7,932 tons).

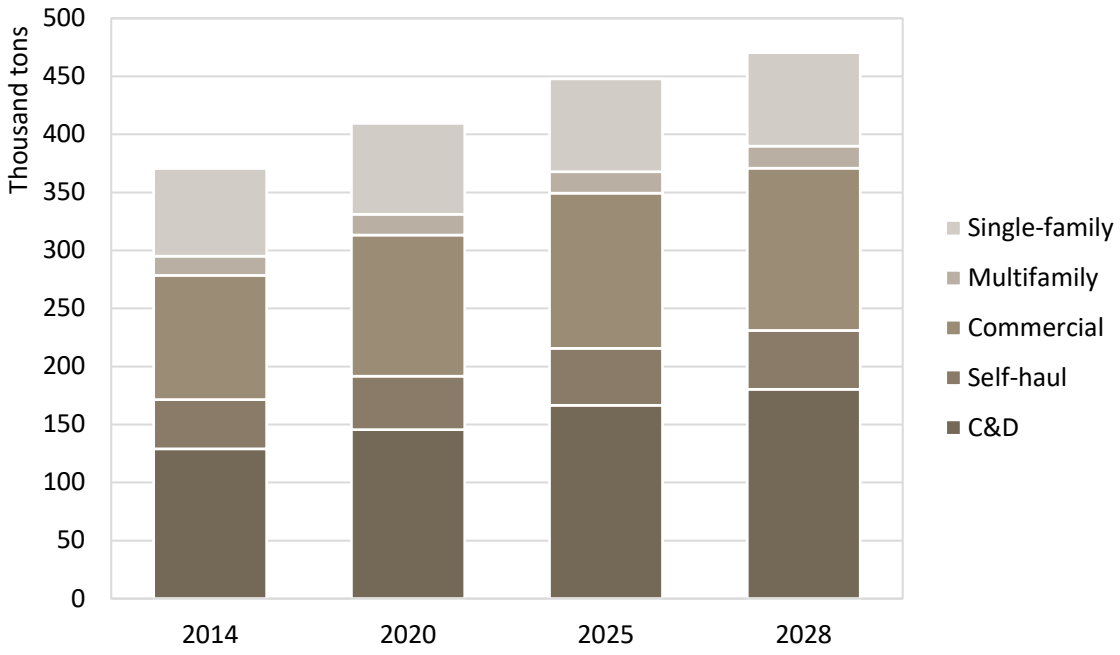
Figure 7. Projected Disposal and Recovery of MSW and C&D, 2014-2028



Generation by Substream

Figure 8 below provides information about generation projections by substream between 2014 and 2028. Projections indicate that C&D and commercial generation will both increase substantially in this time frame: C&D generation by 51,338 tons, and commercial by 32,790 tons.

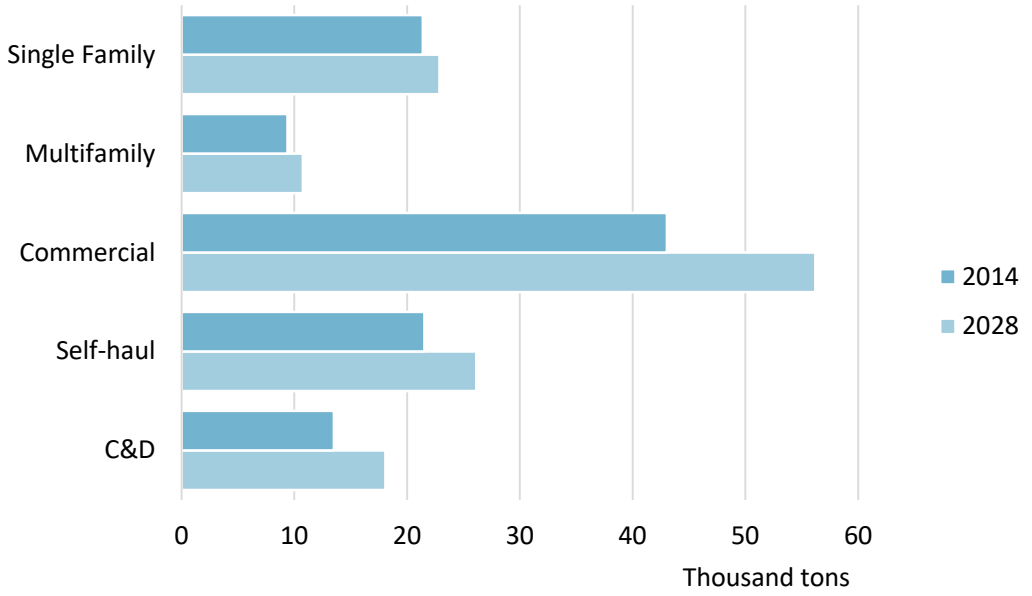
Figure 8. Projected Generation by Substream, 2014-2028



Projected Recoverable Waste in the Disposal Stream

Figure 9 presents projections for the tons of recoverable waste bound for disposal. By 2028, the commercial substream is projected to present the largest opportunity for recoverable materials in the garbage stream (at 56,201 tons), followed by the self-haul (26,130 tons) and single-family (22,875 tons) substreams.

Figure 9. Projections of Recoverable Waste for Disposal, 2014 and 2028



4. Recommended Strategies

This section summarizes recommended strategies to attain 70 percent diversion by 2028. Recommended staffing and capital improvements included in the plan also serve to build a foundation for moving well beyond the 70 percent goal.

70 Percent by 2028

Overview of plan to achieve 70 percent

Achieving 55 percent diversion as shown in **Figure 1** is significant, making the city a national leader in recycling. This high level of performance reflects the City's sustained efforts over time to implement state-of-the-art curbside and self-haul recycling programs and educate citizens and businesses to participate in those programs.

However, much more recovery is needed to achieve 70 percent diversion by 2028, especially considering the expected growth in waste over time due to population and economic growth. To achieve the 70 percent recycling rate by 2028, the City will need to recover an additional 62,000 tons, or about 50 percent of the recoverable tons in Tacoma's disposed waste stream. These tons will need to come from new and expanded programs, investments, incentives, regulations, and other initiatives.

The plan recommends that Tacoma implement these changes in four phases over the next 12 years. The overriding purpose of this phased approach is to plan well for and cost effectively attain the 70 percent diversion goal, with stakeholders and the public regularly informed of progress and the City Council

making informed decisions about when to implement needed policies, programs, and investments that take into account the potential impact on rates.

The proposed plan incorporates a "voluntary first" approach and suggests utilizing existing infrastructure and systems, where possible, to increase diversion. In Phase I, the emphasis is on expanding education, outreach, and technical assistance with only limited mandates and investment in new or upgraded facilities. Decisions on whether to implement major new capital investments and considerations about additional mandates are deferred to the end of Phase I and to the start of Phase II.

In this way, Environmental Services (ES) can move incrementally, with full Council and stakeholder buy-in to adopt policies and make investment decisions as needed. With this approach, ES can also effectively manage the associated risks, including changes in technology, escalating costs, and the possibility of lagging participation and/or growth in waste generation that would require more intensive use of mandates and increased investments in new technology. Each of the four phases is described below:

Phase I runs from 2017-2020 and features vigorous implementation of new education and outreach initiatives, coupled with selected, highly targeted regulations, incentives, and investments. These initiatives are expected to increase diversion by 22,800 tons by 2028, increasing the recycling rate from 55 percent to 62 percent. Phase I costs include approximately $950,000 (2015 $)[4]of capital investment, with estimated operating cost of the programs at about $950,000 per year beginning in 2017 and increasing to $1.3 million by 2020. These costs would be offset by annual revenues from marketable commodities starting at about $15,000 and rising to $25,000 per year by 2020, depending on market conditions.

Phase II runs from 2021-2022 and adds new regulations and education initiatives, increased organics collection and processing capacity, and related operational changes. These efforts are expected to increase diversion by an additional 31,800 tons, or 6 percentage points to 68 percent by 2028. Phase II costs include $14.2 million (2015 $) in capital costs for mixed organics processing capable of handling yard and food waste as well as compostable paper. The estimated operating cost of all Phase II programs is approximately $1.1 million (2015 $) per year beginning in 2021 and increasing to $1.6 million by 2022. These costs would be offset by annual revenues from marketable commodities starting at about $60,000 and rising to $100,000 per year by 2022, depending on market conditions. In this period, the City will need to decide whether and how to add material recovery facility (MRF) capacity to the system by 2028, an alternative means of increasing diversion to customer-facing education programs and mandates.

Phase III begins in 2023. While it is premature at this point to say exactly what programs and investments will be implemented, Phase III will likely include continuing with mandates to increase diversion by an additional 12,200 tons by 2028, resulting in a 71 percent recycling rate. These Phase III costs would include an estimated $85,000 in operating cost for the programs starting in 2023 and rising to $435,000 by 2028. Alternatively, bringing on MRF capacity could result in a 7 point increase in diversion by 2028, from 68 percent to 75 percent, and would require approximately $33 million (2015 $) in capital costs, and annual operating costs starting at $250,000 in 2023 and rising to $5.9

[4] All costs in this section are expressed in 2015 dollars.

million when the MRF comes on line. Both Phase III with and without a MRF would produce revenues to offset costs. Phase III programs without a MRF would produce about $5,000 in revenues, while Phase III programs with a MRF would produce $260,000 in revenues beginning in 2023 and rising to $4.9 million when the MRF begins operations in 2028. All of these revenue figures would depend on market conditions.

Phase IV starts in 2029 with new targets established at that time. This phase includes programs and initiatives to get the City to 76 percent diversion by 2032. With MRF capacity, the City could achieve 78 percent diversion by 2032. Phase IV capital costs would be approximately $8.9 million (2015 $), with annual operating costs of approximately $570,000 in 2029 and rising to $800,000 in 2032. Phase IV produces some revenues to offset these costs, estimated at this time to be nominal. If necessary to meet the 70 percent recycling goal, these programs and initiatives, in particular the regulations, could be implemented prior to 2028.

Figure 10 depicts the increase in diversion related to each phase. **Table 2** shows net new average annual costs between 2017 and 2032 to achieve that additional diversion.[5] The full implementation of Phase I, II, and III will result in a reduction in tonnage disposed at the landfill. Based on the current disposal costs of $47 per ton, the estimated average annual value between 2017 and 2032 of this avoided disposal is $2.1 million per year.

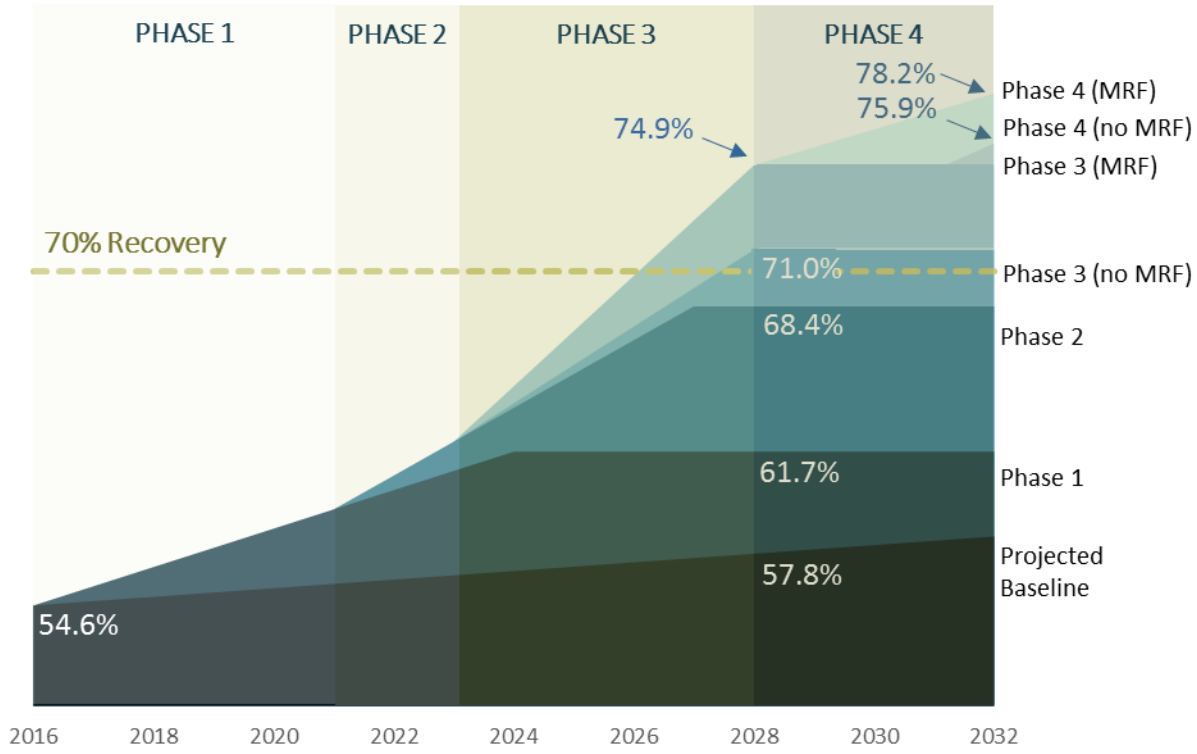
Costs of new diversion efforts would be met in part through reallocation of existing labor, cost savings from operational efficiencies, and reduced disposal costs. Any increases in funding needed would be addressed through the normal ratemaking process, which involves calculating impacts to rates through the City's rate model, review and recommendation from a citizen's Environmental Services Commission, and subsequent review, input, and approval by the City Council.

Table 2. Net Average Annual Costs by Phase

Phase	Average Annual Through 2032
Phase I	$727,843
Phase I, II	$2,165,402
Phase I, II, III No MRF	$2,379,484
Phase I, II, III w/ MRF	$3,314,353
Phase I, II, III No MRF, IV	$2,675,492
Phase I, II, III w/ MRF, IV	$3,604,051

[5] Net annual average costs between 2017 and 2032 are expressed in 2015 dollars and assume a 20-year asset life for major investments and net cash flows for each phase and combination of phases (including direct and staffing costs for program and education activities, fixed operation and maintenance costs, amortized capital expenditures, and revenues).

Figure 10. Recovery Estimates Resulting from SMMP Implementation, 2016-2032



Diversion Options

In developing the SMMP, the Cascadia Team and the ES considered a comprehensive set of options. In total, the team considered over 100 specific policy, programmatic, investment, or operational options and incorporated 73 into the recommended plan (refer to Appendix 4 for a detailed list of the 73 options). These options fall into six different categories as described below.

Waste Reduction/Extended Producer Responsibility (EPR)

This category primarily consists of: 1) engaging producers to take responsibility for the end-of-life management of certain products and packaging (extended producer responsibility) and 2) educating customers about their waste reduction options. Options evaluated as part of the planning process include providing outreach specific to waste reduction and prevention (mostly focused on single and multifamily customers, though potentially expanding to reach other customers); launching a food waste prevention education campaign for single-family customers; promoting reuse and supply chain management to self-haul and commercial customers; and promoting EPR. This category does include one option that is not explicitly education related: establishing ongoing reuse drop-off events for self-haul customers.

Education & Outreach

This category includes general and targeted education, outreach, and technical assistance. Options include targeted outreach to different customer segments, general education, application of

community-based social marketing principles, technical assistance, and a Master Recycler/Composter program. This category also covers the promotion of existing recycling and reuse opportunities for single-family, multifamily, and self-haul customers; C&D debris salvage and green building strategies for C&D commercial and C&D self-haul customers; and organics diversion strategies for single-family and commercial customers.

Operations & Programs

This category is focused on options that ensure sufficient programmatic and physical infrastructure is in place to support the City of Tacoma's diversion efforts. Options within this category include providing adequate recycling infrastructure for multifamily customers and expanding food waste collection and green reuse and purchasing opportunities for commercial customers. In later years, options include expanding the recyclable materials collected curbside for single and multifamily customers; enhancing the floor sorts at the TRTC; designing commercial routes to collect and process highly recoverable waste; and holding neighborhood swap and repair events to serve residential customers.

Capital Investments

The capital investments considered are intended to provide adequate and high-performing collection and processing capacity for Tacoma's recoverable materials. Options include expanding mixed organics processing capabilities and expanding collection to accommodate compostable paper and food serviceware. Capital investments evaluated in later phases of the plan include investing in or contracting new MRF capacity and expanding mixed organics processing capacity. It is important to note here that this investment in new processing capacity could happen in several different ways, including directly by the City, via a public-private partnership, or through a contract arrangement with an existing or new private entity.

Incentives & Rates

Incentives and rates considered included (but were not limited to) providing incentives for self-haul customers to increase diversion at the TRTC and increasing pay-as-you-throw (PAYT) rate differentials for residential customers.

Regulations

Possible mandates, including disposal bans and mandatory recycling, were evaluated. As discussed earlier, these mandates and regulations were considered as a last resort or in selected instances where specific barriers could be cost-effectively overcome with a mandate and where public acceptance was deemed high. Regulations were specifically considered as an alternative to investing in new MRF capacity. Regulations evaluated include requiring adequate infrastructure for recycling by commercial customers; requiring job site recycling for C&D customers; implementing mandatory recycling laws that affect residents; and requiring recycling and composting at large events held on public property.

Phase I (2017-2020): Intensive Education & Outreach; Limited Regulations

The purpose of Phase I is to increase recycling and waste prevention voluntarily with minimal new investment and regulations. These efforts build on existing successful outreach and education initiatives, such as the Knock & Talk campaigns, and take advantage of the excellent collection programs and infrastructure already in place in the city. These efforts also build the groundwork for designing and implementing Phase II and Phase III diversion programs.

The recommended plan calls for implementing 19 types of new programs and initiatives affecting all types of waste generators (**Table 4**). These programs and initiatives are projected to divert an additional 22,800 tons by 2028 and increase in the recycling rate by seven percentage points, from 55 to 62 percent.

Phase I costs include about $950,000 (2015 $) of capital investment.[6] The estimated operating cost of these new programs will be approximately $950,000 per year beginning in 2017 and will increase to $1.3 million by 2020.

Staffing for these initiatives is calculated to be about 8 FTE, with $300,000 invested in the first year and $100,000 annually in the following four years for contractor support services.

These costs would be offset by annual revenues from marketable commodities starting at about $15,000 and rising to $25,000 per year by 2020, depending on market conditions.

Of the 19 programs that comprise Phase I, the majority are planned to begin in 2017. Most of these have a ramp-up period of 3 to 5 years.

Estimated diversion of these programs by substream when fully implemented are presented in **Table 3** below.

Table 3. Diversion by Substream from Phase I (2017-2020)

Substream	Total Tons
Single-family and Multifamily	2,200
Multifamily only	1,200
Commercial (Non-C&D)	5,600
Self-haul (Non-C&D)	2,800
C&D	4,300
Cross cutting (more than one substream)	6,600
TOTAL	**22,800**

Of the 19 types of programs that comprise Phase I, many are planned to begin in 2017. Most of these have a ramp-up period of 3 to 5 years, allowing time for planning, program design, materials development, and other start-up activities before full implementation. Eight individual programs

[6] All costs in this section are expressed in 2015 dollars.

involving changes in rate structures and operations are scheduled for initial implementation in 2019. Three programs involve implementing new regulations that will take effect in 2020.

Table 4 provides a consolidated summary of these programs. A more detailed discussion of these programs is provided after the table.

Table 4. Phase I (2017-2020) Program Summary

Category	Elements
Waste Reduction/ Extended Producer Responsibility (EPR)	Provide education and outreach on waste reduction and waste prevention
	Promote reuse and supply chain management
	Promote EPR
	Implement campaign to reduce food waste
Education & Outreach	Provide technical assistance (including Master Recycler/Composter program)
	Deliver targeted education and outreach
	Promote reuse and recycling opportunities
	Promote C&D debris salvage and green building practices
	Promote organics diversion strategies
Operations & Programs	Ensure adequate infrastructure for commercial recycling
	Increase reuse and green purchasing
	Expand public space recycling
	Promote plastic bag take-back program
	Promote waste diversion strategies
	Expand food waste collection
Incentives & Rates	Provide incentives to increase diversion at Tacoma Recovery and Transfer Center (TRTC)
	Promote and provide incentives for food grinders
Regulations	Require adequate infrastructure for recycling
	Require use of certified C&D processing facilities and enforce "two-bin rule"

Waste Reduction & Extended Producer Responsibility

Phase I recommends seven new waste reduction and EPR initiatives, which together are estimated to divert 1,100 tons. These include:

- Providing outreach on waste prevention and toxics reduction, with special programs tailored to reach multi-cultural communities.
- Promoting green procurement and supply chain management.
- Expanding waste reduction and recycling education in schools.
- Undertaking a campaign to increase food waste diversion.
- Promoting EPR for hard-to-recycle materials (e.g., mattresses, paint, pharmaceuticals, batteries).
- Promoting thrift stores as an option for discarding unwanted furniture.

The level of effort required to implement these initiatives varies widely, and the benefits are expected to mostly occur over the long term. These programs are, for the most part, more about achieving a sustainable materials management system than increasing diversion. For example, education on toxics is expected to reduce the use of harmful materials but will have a minimal impact on diversion.

Education & Outreach

Phase I recommends a wide range of new, continued, or expanded education and outreach programs–21 initiatives in total estimated to divert 14,000 tons by 2028. The most significant of these efforts is a continuation of current education and outreach to new and existing customers, which is expected to increase diversion from all generator types by an additional 6,200 tons between now and 2028. Other important programs in terms of diversion include:

- Promoting C&D salvage, reuse, recycling, and exchange to residents.
- Revamping some of the existing education materials to increase their impact.
- Providing targeted education and outreach to the multifamily substream.
- Expanding commercial technical assistance.
- Conducting targeted education and outreach to increase food waste collection.

Operations & Programs

Phase I recommends seven initiatives that involve investing in new facilities or creating and/or expanding collection programs; these initiatives are projected to divert 2,600 tons from the waste stream by 2028. Key efforts include:

- Working with the private sector to expand food waste collection to include compostable paper and food serviceware.
- Ensuring that all multifamily sites have adequate recycling and organics collection infrastructure.
- Promoting and providing incentives for the use of residential food grinders.
- Establishing a voluntary initiative for disposable plastic bag take-back at grocery stores.

Phase-in of these activities begins in 2019, providing time for planning, design, and working out agreements with the private sector as needed.

Incentives & Rates

Phase I recommends rate structures that provide incentives for increased source separation by self-haul customers at the transfer station. These are intended to target the recoverable materials that often, for convenience, end up disposed as waste, such as C&D, yard waste, carpet, and tires. An estimated 2,000 tons of material would be diverted using these incentives by 2028.

Capital Investment

Capital investment requirements for Phase I include: funding for adequate multifamily collection infrastructure, food waste collection, public space recycling, and expansion of the use of food waste grinders. The capital costs are associated with the program and operational changes discussed above total $950,000.

Regulations

Phase I recommends three regulatory initiatives that target the commercial substream and are projected to divert an estimated 3,100 tons by 2028:

- Enforcing the "two-bin" rule for construction sites: sites with a recycling container are required to have a garbage container as well, to prevent contamination of recyclable materials sent for processing.
- Requiring C&D generators to deliver their debris to certified C&D processing facilities.
- Requiring new commercial buildings to have adequate recycling and composting space and enclosures in order to receive a new building permit.

Phase II (2021-2022): Continue Intensive Education; Additional Regulations; Limited Investment

Phase II consists of 10 types of initiatives, with the emphasis on new regulations as well as selected changes to operational practices and a significant investment in processing capacity to increase mixed organics recovery (**Table 5**). The investment in additional organics processing will provide the capacity to process 30,000 tons of organics (yard and limited amounts of food waste) collected through existing programs, plus an estimated additional 30,000 tons of yard waste, food waste, and compostable paper, which will be diverted through new Phase I and II programs. Please see Appendix 6 for a more detailed description of this facility and associated cost estimates.

The new Phase II regulations, investments, operational changes, incentives, and programs, are estimated to divert an additional 31,800 tons by 2028. This will increase the overall recycling rate by six percentage points, from 62 to 68 percent.

Phase II costs include $14.2 million (2015 $) in capital costs for mixed organics processing capable of handling yard and food waste as well as compostable paper. The estimated operating cost of all Phase II programs is approximately $1.1 million (2015 $) per year beginning in 2021 and increasing to $1.7 million by 2022. The annual O&M costs include about $900,000 for the organics processing facility, which will ramp up over time. These costs would be offset by annual revenues from marketable commodities starting at about $60,000 and rising to $100,000 per year by 2022, depending on market conditions. In addition, since this planned investment in expanded organics processing is sized to replace existing processing of yard waste, substantial savings (approximately $2.1 million per year) will be realized.

Table 5 summarizes the elements that comprise Phase II.

Table 5. Phase II (2021-2022) Program Summary

Category	Elements
Waste Reduction/ EPR	Establish reoccurring reuse/drop-off events
Operations & Programs	Expand materials accepted curbside
	Enhance floor sorts at TRTC
Incentives & Rates	Increase pay-as-you-throw rate differentials
Capital Investment	Expand mixed organics processing capacity, and expand collection to accommodate compostable paper and food serviceware
Regulations	Require recycling of recoverable C&D materials
	Require job site recycling and enforce existing two-bin rule
	Require multifamily property owners to provide recycling collection service
	Ensure adequate collection infrastructure for multifamily recycling and organics
	Require separation of recyclables at TRTC

Key elements of Phase II that have the most significant impact on diversion are:

- **Require separation of recyclables at the TRTC.** This regulation is proposed for implementation starting in 2022. It affects all transfer station users and will lead to increased diversion of traditional recyclables and more recovery of organics, C&D, electronics, and other recyclables, such as tires and durable plastics. When fully phased in over five years, the regulation is expected to divert an annual 7,400 tons and cost about $165,000 to implement and enforce.
- **Require recycling of recoverable C&D materials.** This regulation, to take effect in 2021, affects the self-haul and commercial C&D substreams and is anticipated to divert 6,300 tons annually when fully implemented after five years. It targets wood, carpet, furniture, mattresses, and other recoverable components of the C&D stream.
- **Expand mixed organics processing capacity and collection to accommodate compostable paper and food serviceware.** This initiative requires a significant change in how Tacoma handles food waste, resulting in collecting and processing additional material that cannot currently go to existing processors. The recommended new processing capacity is planned to start operations in 2023. The benefit is that customers will be able to compost all of their currently generated and anticipated future organics, including yard and food waste and compostable paper. Investment costs are substantial, estimated at $14 million. All types of generators will be affected, most notably commercial and residential customers, who produce most currently disposed food waste. Note that in the future, all organics processing will need to be robust enough to handle compostable paper and food serviceware. However, the City of Tacoma has several options to make this processing capacity available – via direct investment, a public-private partnership, or through an RFP process and contracting with an existing or new private entity for the capacity paid for on a per-ton basis (with no ownership or capital investment requirements on the City's part).

> In the future, all organics processing will need to be robust enough to handle compostable paper and food serviceware.

- **Enhance floor sorts for bulky reusable and recyclable items at TRTC.** This change to the facilities and operations at the transfer station are anticipated to divert an additional 6,400 tons of recoverable C&D, carpet, organics, wood, yard waste, furniture and mattresses. The recovery of these materials is limited due to the condition of these items and the level of contamination. As such, Cascadia used very conservative estimates (15 percent to 40 percent) of the amounts of these materials that will actually be recycled. The cost of this effort is estimated to start at $345,000 annually with an initial investment of $170,000. The new system would be phased in beginning in 2021 and fully effective by 2023.
- **Increase pay-as-you-throw differentials**. Tacoma already has a tiered pricing system for waste disposal. This would increase in 2021 to provide additional incentives for curbside residential customers to recycle and is expected to result in the diversion of 1,400 tons.
- **Expand materials accepted in curbside recycling to include textiles and additional types of scrap metals and plastics.** This change increases diversion from residential curbside recycling by an estimated 1,100 tons.
- **Require multifamily property owners and managers to provide adequate recycling collection services to residents – establishing a "right to recycle."** This effort will divert an estimated 1,000 tons from the multifamily substream.

The ultimate decision about any MRF investment will depend upon how much additional diversion has actually been achieved and at what cost through the Phase I "voluntary first" approach and the expected impact of Phase II regulations.

The remaining regulations and other initiatives which primarily target C&D, self-haul, and multifamily substreams are expected to divert an estimated 2,600 tons from the waste stream when fully implemented.

In Phase II, ES will need to decide whether to acquire new sorting and mixed waste processing capacity to divert additional materials from the residential, non-C&D commercial, and/or self-haul substreams. Several options are possible, as detailed in the MRF study that is part of the sustainable materials management planning effort. The plan anticipates that an integrated MRF will likely be the best option, as described in Option 4 of the *Volume 3: MRF Feasibility Study*. For Option 4, the MRF would have an integrated equipment line that would process the residential commingled recyclables stream, a high-grade non-C&D commercial waste stream, and a high-grade non-C&D self-haul waste stream. Option 4 assumes that the City would alter collection routes to generate commodity-rich dry commercial loads and expand tip floor sorting of self-haul loads.

The ultimate decision about any MRF investment will depend upon how much additional diversion has actually been achieved and at what cost through the Phase I "voluntary first" approach and the expected impact of Phase II regulations. Tacoma needs to make a decision regarding investment in MRF capacity by 2022-2023 in order to allow enough time for planning, financing, design, and construction of a new facility (either by the City or a private entity) that can be operational by the beginning of 2028 and thus contribute to the City's 70 percent goal.

Alternatively, Tacoma can decide to continue with and expand the mix of regulations, incentives, education, and operational changes as the basis for attaining the 70 percent goal, as further described in the Phase III section below.

Phase III (2023-to 2028): Maximum Regulations & Programs or Acquire MRF Capacity

Though highly speculative at this point, Phase III without a new MRF would consist primarily of new regulations mandating recycling services and practices. The list of potential options includes:

- Authorizing mandatory recycling laws for targeted materials.
- Requiring businesses with outdoor garbage bins for public use to provide adjacent recycling containers.
- Requiring commercial property owners and businesses to provide recycling collection service (subscription or self-haul).
- Mandating that food service establishments use recyclable and/or compostable food serviceware.
- Requiring large events on public property to recycle and compost.

Taken together, these regulations are projected to divert 12,000 tons annually when fully implemented over 3 to 5 years. Other elements of Phase III include creating an award/recognition program for businesses and holding neighborhood swap and repair events; together, these programs would divert an estimated 200 tons. If all other programs are performing as expected, these options would enable Tacoma to achieve a 71 percent recycling rate by 2028.

The heavy regulatory approach that comprises Phase III is a departure from the City's preference for voluntary behaviors and practices. Accordingly, the City will need to decide whether a regulatory or MRF-based approach is preferred in achieving the 70 percent goal or potentially continue to increase focus and investment in voluntary programs, if those appear to be performing better than expected.

Investing in an integrated MRF that processes commingled recycled materials plus dry commercial waste, along with dry waste routing and banning wood at the Tacoma Recovery & Transfer Center, would divert an additional 30,000 tons and achieve a 75 percent recycling rate by 2028.

Additional costs associated with the MRF would include $33 million in capital investments and annual operating costs starting at approximately $5.4 million (2015 $) and increasing with growing volumes. These costs would be offset by revenues starting at an estimated $4.9 million per year based on 10-year average commodity prices, and with the potential to ramp up with increased volumes processed, depending on market conditions.

Table 6 summarizes these Phase III options.

Table 6. Phase III (2023-2028) Program Summary

Category	Elements
Education & Outreach	Implement intensive award and recognition programs
Operations & Programs	Design routes to collect highly recoverable waste
	Hold neighborhood swap and repair events
Capital Investments	Invest in or contract new MRF capacity
Regulations	Authorize mandatory recycling laws
	Ban wood disposal at TRTC
	Require adequate infrastructure for recycling and organics collection
	Mandate food service establishments to use recyclable and/or compostable food serviceware
	Require large events on public property to recycle and compost
	Require subscription to recycling and organic collection service

Phase IV (Beyond 2028): Optional Strategies to Exceed 70 Percent

The strategy presented above – the three-phase approach to implementing education and outreach programs, new regulations and incentives, operational changes, and investments – is designed to achieve the 70 percent goal by 2028. Modeling indicates that Tacoma can achieve 76 percent diversion through new education and outreach programs, new regulation and incentives, and operational changes without investing in or contracting for a mixed waste MRF. Modeling predicts that those strategies combined with investment in a mixed waste MRF could bring Tacoma to 78 percent diversion by 2028.

The City of Tacoma, however, considers the 70 percent goal to be a "waypoint" towards a truly sustainable materials management system that virtually eliminates waste, creates value for discards, and minimizes the negative environmental impact of materials throughout their entire life cycle. To go beyond 70 percent with today's technologies and material economics, the City could consider additional regulations and programs as shown in **Table 7**. Regulations that have the greatest potential impact are:

- Requiring composting for organic materials (including food waste, yard waste, compostable paper, clean wood, and other compostable products) for all generators, potentially diverting an additional 11,300 tons when fully implemented in 2032. Note that this option would require investment in robust new organics processing capacity.
- Mandating recycling of traditional materials for all generators, possibly diverting 10,800 incremental tons when fully implemented in 2032.

These and other policies and programs summarized in the table below could push the recovery rate to over 76 percent without a MRF and to 78 percent with a MRF by 2032. Either of these achievements would put Tacoma in a true leadership position in sustainable materials management and represent an upper-bound in terms of cost-effective, feasible diversion.

Achieving 76 or 78 percent diversion would put Tacoma in a true leadership position in sustainable materials management and represent an upper-bound in terms of cost-effective, feasible diversion.

Table 7. Phase IV (Beyond 2028) Program Summary

Category	Elements
Capital Investments	Co-locate Advanced Recycling Technology at TRTC
	Include a retail reuse and recycling center at TRTC for salvage building materials and other items
Regulations	Require composting for organic materials
	Mandate recycling for traditional recyclables

Substream/Material Specific & Cross-Cutting Strategies

The City of Tacoma defines sustainable materials management as "an approach that includes waste prevention and discard management, while seeking to reduce environmental impacts by managing materials through all stages of their life." Achieving true sustainability as a community will require addressing the triple bottom line – economics, community, and environment – to ultimately improve the quality of life for all who live and work in Tacoma. This section discusses the issues and strategies specific to materials and substreams that make up significant portions of the waste stream and are essential to achieving this sustainability vision.

Upstream EPR/Reducing Life Cycle Impacts

Material consumption and waste has both upstream and downstream impacts. Environmental degradation, toxics pollution, and large quantities of greenhouse gas emissions are associated with material extraction, processing, manufacturing, and transport to market. Likewise, within Tacoma and at the point of disposal, waste negatively affects the environment, causing litter, stormwater runoff filled with trash, and other related problems.

The City of Tacoma defines sustainable materials management as "an approach that includes waste prevention and discard management, while seeking to reduce environmental impacts by managing materials through all stages of their life."

The City of Tacoma can mitigate these impacts significantly through effective materials management programs and policies – collecting traditionally recoverable materials such as paper, plastics, cardboard, metals, and glass for recycling and organics for composting; and ensuring that transfer stations, recycling and composting facilities, and landfills meet the highest environmental standards. Tacoma also contributes to a reduction in life cycle impacts by educating the public about waste prevention, thereby eliminating unnecessary consumption and waste.

The purpose of extended producer responsibility is for hard-to-recycle product manufacturers (producers) to step up and take responsibility for the end-of-life management of their materials, including covering some or all of the associated cost.

However, for certain materials and products, the City's ability to effectively manage the waste stream is limited. These include hard-to-recycle materials such as paints, hazardous wastes, batteries, carpet, pharmaceuticals, and electronics. These materials can be costly to collect and handle, often require separate materials collection and handling facilities, and can have weak or limited markets. Solutions for these hard-to-recycle materials often require scale in collection and processing across multiple jurisdictions, scale that does not currently exist for most products.

The purpose of extended producer responsibility (EPR) is for hard-to-recycle product manufacturers (producers) to step up and take responsibility for the end-of-life management of their materials, including covering some or all of the associated cost.

This plan calls for the City of Tacoma to collaborate with other municipalities, governments, and NGOs in Washington and beyond to advance EPR policies and practices for hard-to-recycle materials. Only collective action and public pressure are likely to succeed at engaging producers in EPR and enacting state-level policies that require EPR. The City of Tacoma should continue to engage on this front, including activities such as continuing to be a member of the Northwest Product Stewardship Council and related organizations and having governmental relations staff support relevant legislation. This is a long-term investment, but one that is likely to yield significant benefits in terms of a more sustainably managed material stream and solutions that enable recovery of traditionally non-recyclable discarded products and packaging.

Minimizing Disposable Products/Plastics

A significant percentage of the waste generated in Tacoma is products and packaging that have a short life span – such as single-use, single-serve packaging; food service packaging; plastic bags; flexible plastics packaging; and composite materials.

A significant percentage of the waste generated in Tacoma is products and packaging that have a short life span – such as single-use, single-serve packaging; food service packaging; plastic bags; flexible plastics packaging; and composite materials. These materials are difficult to recycle and/or create material handling and litter problems, including plastic debris in water bodies. These materials are also increasing in the waste stream, and some believe that we are continuing unabated towards a throw-away society that is ultimately unsustainable.

This plan includes policies, programs, and actions to reduce disposable products and, in particular, address the problems with plastics in Tacoma's waste stream. Recommended actions include:

- Banning plastic bags.
- Providing consumer education and outreach.
- Offering education and outreach to food service establishments to encourage a shift to recyclable and/or compostable material.
- Working in coalitions to advance EPR solutions – making manufacturers responsible for end-of-life management of selected packaging and products.
- Banning non-recyclable or non-compostable food serviceware.

Other actions that could be considered in the future include:

- Banning expanded polystyrene.
- Instituting incentives for increased use of recyclable or compostable packaging and/or fees on non-recyclable or non-compostable packaging.

C&D Materials

Tacoma faces several challenges as it tries to increase recovery and reuse of C&D materials:

- Contractors are ignoring the "two-bin" rule requiring a garbage container if a recycling container is also placed on a job site.
- A significant percentage of C&D material that is collected for recycling is likely waste and not, in fact, recyclable.
- Some materials that are collected for recycling and are recyclable are, in fact, not recycled.
- Tacoma has minimal control over the C&D stream. It is virtually impossible to ensure sustainable materials management practices are in place with such limited control.
- A large quantity of recyclable C&D material is received at the transfer station and, rather than being separated for recycling, ends up disposed as garbage in the landfill.

These problems are the same as those faced by jurisdictions throughout Washington. The City of Seattle and King County are addressing similar issues using a regulatory approach, as are many municipalities in California.

Solutions to C&D recovery challenges in Tacoma that are proposed in this plan include:

- Enforcing the "two-bin" rule, issuing citations and assessing fines if needed.
- Requiring that C&D processing facilities be certified, and then requiring that contractors and haulers take their C&D debris to these facilities. To be certified, facilities would need a plan and the ability to document that waste generated as a by-product of recycling at the facility does not exceed a legislated threshold. For example, some jurisdictions have set this threshold at 10 percent.
- Providing financial incentives for source separation of recoverable C&D at the transfer station, initiating more aggressive tip floor sorts at the transfer station and ultimately requiring recycling or banning disposal of C&D materials.

Commercial Substream

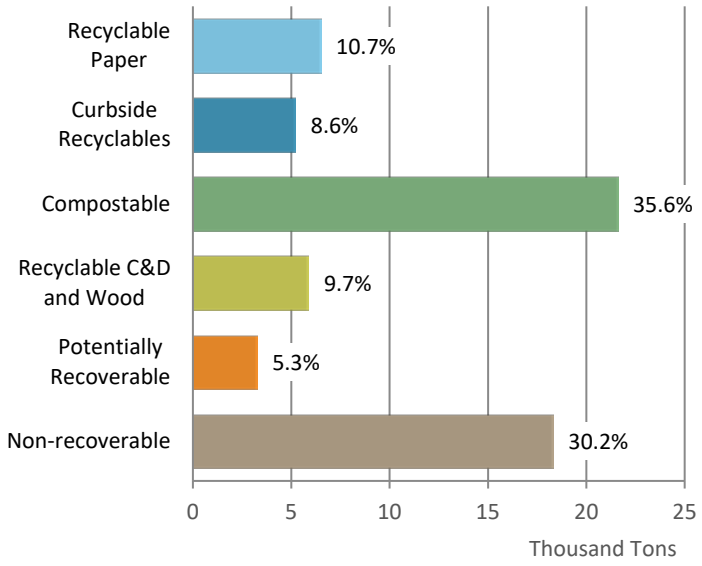
Discards from the commercial substream are a large and growing portion of the overall waste stream: much of this material is recyclable. As of 2014, commercial waste is 37 percent of the total Tacoma waste stream (**Figure 4**), the recycling rate is 42 percent (

Discards from the commercial substream is a large and growing portion of the waste stream, and much of this material is recyclable.

Figure 5), and 70 percent or about 43,000 tons are recoverable (**Figure 6**).

Figure 11 shows the composition of this commercial waste, highlighting the portions that could be recycled or composted, including Compostable materials (35.6 percent), Recyclable Paper (10.7 percent), Recyclable C&D and Wood (9.7 percent), and Curbside Recyclables (8.6%). Challenges businesses face in recycling, especially smaller businesses, include limited service and, for food service establishments, inadequate space or lack of attention to front-of-house food waste recovery. Experience suggests that private recyclers and the City are already capturing the "low-hanging fruit," but much still needs to change to maximize diversion, including human behavior, facilities, and operating practices.

Figure 11. Summary of Recoverability of Overall Commercial Waste



This plan recommends full implementation of multiple strategies to increase commercial substream diversion. These include:

- Providing intensive education, outreach, and technical assistance to the commercial substream, including Knock & Talk campaigns.

- Expanding the food waste collection program and securing or developing a more robust processing capability in order to accommodate compostable paper and food serviceware.
- Requiring adequate infrastructure at all businesses for recycling and organics collection.
- Implementing high-profile awards and recognition programs.
- Providing adequate price incentives.

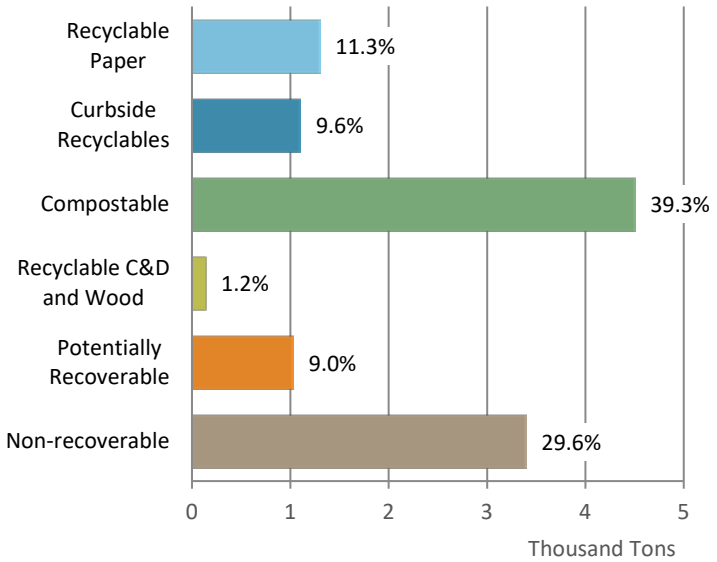
Multifamily Substream

The multifamily substream currently has a 19 percent recycling rate (

Figure 5), and approximately 70 percent of multifamily disposed waste is recoverable (**Figure 6**). While representing only 8 percent of the waste stream (**Figure 6**), the multifamily substream is growing much faster than the single-family substream and houses a large percentage of Tacoma's historically underserved populations. Obstacles to higher diversion in a multifamily environment include lack of a price signal to individual household generators, inadequate space and facilities, inattentive property managers, insufficient recycling service, and a relatively transient population that can be difficult to reach and expensive to educate.

Figure 12 provides more information about the composition of recoverable materials in the multifamily waste stream. Compostable materials make up 39.3 percent of the stream, followed by Recyclable Paper (11.3 percent), Curbside Recyclables (9.6 percent), and Recyclable C&D and Wood (1.2 percent).

Figure 12. Summary of Recoverability of Multifamily Residential Waste



True sustainability requires attending to the triple bottom line – environment, economic, and community. Accordingly, this plan calls for new and intensive efforts by the City to improve recycling in the multifamily substream, especially for historically underserved populations and those that have been traditionally more affected by pollution – lower income communities, communities of color, and immigrant communities. With the goals of achieving equity in both service offerings and participation, recommended programs and initiatives include:

- Providing technical assistance to multifamily property managers and residents.
- Offering innovative education and outreach campaigns to reach and engage diverse communities.
- Increasing investment in and improving collection infrastructure.
- Requiring recycling and organics collection service.
- In Phase II, requiring property managers to provide adequate collection infrastructure.

At a 55 percent recycling rate, the single-family substream is achieving a very high rate of recovery, within range of other waste reduction and diversion leaders like Seattle and San Francisco.

Nonetheless, the City still has room for improvement in this sector. About 63 percent of the single-family disposed waste stream is recoverable, an opportunity of about 21,400 tons in 2014.

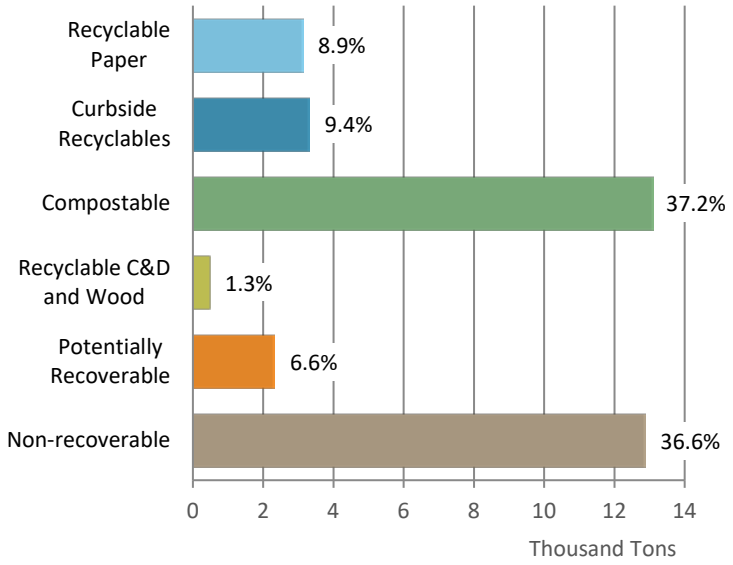
Single-family Residential Substream

At a 55 percent recycling rate (

Figure 5), the single-family substream is achieving a very high rate of recovery, within range of other leaders like Seattle and San Francisco. Tacoma's well-managed roll-out of every-other-week garbage collection and curbside food and yard waste collection with extensive education (including Knock & Talk campaigns), can be credited with a lot of this success. Nonetheless, the City still has room for improvement in this sector. About 63 percent of the single-family disposed waste stream is recoverable, an opportunity of about 21,400 tons in 2014 (**Figure 4**).

Figure 13 provides more information about the composition of recoverable materials in the single-family waste stream. Compostable materials make up 37.2 percent, followed by Curbside Recyclables (9.4 percent), Recyclable Paper (8.9 percent), and Recyclable C&D and Wood (1.3 percent).

Figure 13. Summary of Recoverability of Single-family Residential Waste



Recommended strategies for increasing recycling in the single-family substream that are in this plan include:

- Continuing intensive education and outreach efforts, with periodic Knock & Talk campaigns, the application of CBSM principles, and development of updated, revamped outreach materials.
- Promoting and providing incentives for the use of food grinders.
- Increasing pay-as-you-throw rate differentials.
- Expanding curbside collection to include textiles and additional types of scrap metals and plastic.
- If needed in Phase III and preceded by an extensive education campaign, authorizing mandatory recycling for selected materials.

5. Conclusion and Recommendations

With a combination of new collection programs, processing infrastructure investments, incentives, regulations, and education—all at an affordable net cost—a 70 percent diversion by 2028 is well within the City of Tacoma's reach. Achieving this diversion level will require timely decision-making, up-front investment, a sustained focus on implementing new and innovative strategies, and leadership to ensure the support of the public and key stakeholders.

The consultant team recommends the following process for achieving Tacoma's 70 percent goal in 2028 and then moving beyond that goal toward a zero waste future:

- Fully implement Phase I and II including expanded organics processing capability.
- Assess progress in 2022 and decide whether to pursue the Phase III regulatory-based approach for achieving the 70 percent goal in 2028 or a technology-based approach that relies heavily on a new MRF. Based on cost, the consultant team recommends the Phase III regulatory approach

that is designed to meet the 70 percent goal at a substantially lower cost than investing in a new MRF.

- Assess progress in 2028 and decide whether to implement the more rigorous Phase IV regulations or consider new investments in technology such as an integrated MRF or other alternative technologies that may become available over the next 12 years. The consultant team recommends implementing the Phase IV regulations first.

Regardless of the approach attaining the 70 percent goal will demonstrate the City's commitment to sustainability, providing long-term environmental, economic, and community benefits to residents, businesses, and institutions alike.

6. Appendices

Appendix 1. Glossary

This glossary defines some terms in this plan that may be unfamiliar to the lay reader, or that are defined differently in the context of this work than in typical use.

These terms are listed in alphabetical order.

Capture Rates	For a given recoverable material, the capture rate is the proportion of the material that is recovered for recycling or composting rather than disposed. For this plan, capture rates were calculated by dividing the total tons of recyclables collected in recycling programs by the total tons of recyclables collected in recycling programs plus the amounts disposed.
Commingled Recyclables	Commingled recyclables are the recyclables that the City of Tacoma will accept at the curb from businesses and residences. They are paper, plastics, aluminum, and cardboard, mixed in the same curbside cart for collection.
Construction and Demolition (C&D) Debris	Construction and Demolition (C&D) debris is the waste that results from construction and/or demolition projects. These include materials like wood waste, concrete, asphalt shingles, gypsum board, and other similar materials.
Diversion	Diversion, when used as a solid waste term, refers to any generated waste that is prevented from entering or removed from a stream of materials that are typically disposed of in a landfill.
Downstream Impacts	Downstream impacts of material consumption and waste include things like landfill overfilling and leachate, litter, stormwater runoff filled with trash, and other related problems.
Durable Plastics	Durable plastics means plastic items other than containers or film plastic, that are large (generally larger than a soccer ball) rigid plastic bulky items. These items are made to last for more than one use. Examples include: crates, buckets (including 5-gallon buckets), baskets, totes, large plastic garbage cans, lawn furniture, large plastic toys, tool boxes, first aid boxes, and some sporting goods. These materials are technically recyclable, but are sometimes made of resins with unstable markets, or combined with other materials like metal, which can make them less desirable for recycling.
Efficiency Rates	Efficiency rates indicate the percentage of the waste stream that the participating group would actually divert.
Generators	Generators are the entities that produce the materials in the waste stream. Generators may include individual residents, businesses, institutions, construction and demolition sites, etc.

Hazardous Waste Streams	Hazardous wastes streams are waste streams made up of materials that mortal [7]
Life Cycle Costs	Life cycle costs are costs that consider every stage of management of a material or program. When applied to materials, life cycle costs consider all costs of material management, from raw materials mining to manufacturing to end-of-life recovery or disposal.
Materials Recovery Facility (MRF)	A Materials Recovery Facility (MRF) is a processing facility that takes mixed waste or recyclables sorts them and prepares them for sale to recyclables commodity markets. The sorting process at MRFs is usually a combination of manual processes (workers that stand along a conveyor belt and sort material as it flows past them) and automatic processes (optical, air, and other automated sorting systems).
Mixed Organics	Mixed organics means an organics stream that is not just one type of organics material, like food waste or yard waste, alone. Instead, mixed organics includes food waste, yard waste, and compostable paper products. Mixed organics streams require municipal composting systems that can handle the diversity of material; many municipal composting systems are designed to handle only yard waste or only food waste, and need to be upgraded to effectively compost a mixed organics stream.
Participation Rates	Participation rates generated for this plan indicate the percentage of a waste generator group that would engage in the desired waste diversion activity or behavior – for example, the proportion of the total population that would participate in a curbside mixed organics collection program.
Per Capita Generation	Per capita generation means waste generation measured per person in a defined geographical area and a defined time period. Per capita generation is often defined in pounds per person per day, week, or year. For the purposes of this study, per capita generation is equal to citywide generation divided by population to measure trends that are normalized

[7] https://www.epa.gov/sites/production/files/2015-09/documents/hwid05.pdf, p.3.

	for population and employment growth over time.
Potentially Recoverable	Potentially recoverable refers to materials that are technically recyclable but for which recovery may be limited due to excessive contamination or a lack of local/regional processing capability and/or viable markets.
Processors	For the purposes of this report, processors are equivalent to MRFs.
Recoverability Potential	Recovery potential is the percentage and tons of waste that could have been recycled or composted, in total for all materials generated, and by substream.
Recoverable Materials	Recoverable materials are materials that may be diverted from the waste stream for recovery by either recycling, composting or other processes that use these materials as a feedstock for reuse or production of another product These materials may include items that are not normally considered as recyclables such as wood waste used for hog fuel or auto body waste.
Recovery Rates	A recovery rate is the ratio of the total amount of recovered materials over the total amount of waste bound for disposal in a specific geographic area.
Recyclable Materials	Recoverable materials are materials that may be diverted from the waste stream for recovery by recycling.
Recycling Rate	A recycling rate is the ratio of the total amount of recycled, composted or recovered materials from the mixed solid waste (MSW) stream over the total amount of MSW generated in a specific geographic area.
Special Waste Streams	Special waste streams are waste streams that exhibit hazardous qualities similar to hazardous wastes. However, the U.S. EPA determined that special wastes necessitated further investigations before being technically classified as hazardous waste, and "were believed to possess less risk to human health and the environment than the wastes being identified for regulation as hazardous waste."[8]
Tacoma Recovery and Transfer Center (TRTC)	The Tacoma Recovery and Transfer Center (TRTC) offers a variety of diversion services for Tacoma residents and businesses all in one place. The Tacoma Recycling Center operates within the Tacoma Recovery and Transfer Center, and accepts self-hauled materials including metal items, glass bottles, plastics, cardboard and paper, batteries, electronics, among other difficult-to-handle materials like used motor oil and packing

[8] https://www.epa.gov/hw/special-wastes

	peanuts. The Recycling Center also accepts recyclables that the city's municipal collection system picks up curbside. Goodwill has a semi-permanent presence at the center, accepting unwanted clothing and household items. Center employees working at the garbage dumping floor survey incoming materials and hand remove materials that can be diverted, an effort that has resulted in significant diversion results. The center also features the EnviroHouse that teaches visitors about sustainable behaviors that they can adopt at home.
Triple Bottom Line	Triple bottom line is a method for measuring program, company, or institutional performance. While traditional performance measurement has focused solely on financial performance, triple bottom line assessments consider social, environmental, and financial aspects of success.
Two-bin Rule	The "two-bin" rule is a recycling related rule for construction sites. Construction sites with a recycling container are required to have a garbage container as well, to prevent contamination of recyclable materials sent for processing.
Universal Waste Streams	Universal waste streams are waste streams of widely generated hazardous wastes that the EPA has streamlined management standards for. Universal wastes include batteries, pesticides, mercury-containing equipment, and mercury lamps.[9] [3]
Upstream Impacts	Upstream impacts of material consumption and waste include things like pollution and environmental degradation due to raw materials mining and material production that result from throwing a material away rather than recycling it. Environmental degradation, toxics pollution, and large quantities of greenhouse gas emissions are associated with material extraction, processing, manufacturing, and transport to market.
Upstream Practices	Upstream practices refer to programs, strategies, or methods that reduce the amounts or eliminate waste before it enters the waste stream. Examples include waste prevention, waste reduction, reuse, EPR, and other practices designed to eliminate waste.
Waste Stream	A waste stream is all of the material that a community generates, including garbage, recyclables, and compostables.
Waste Substreams	A waste substream is determined by the particular generation, collection, or composition characteristics that make it a unique portion of the total

[9] https://www.epa.gov/hw/universal-waste

	waste stream. The waste stream is typically made up of many waste substreams.

Appendix 2. Standardized Data Collection and Reduction Goal Calculations Memo

Overview

To inform development of Tacoma's Sustainable Materials Management Plan, Cascadia identified a range of possible metrics and key performance indicators, researched methodologies for municipal solid waste (MSW) recycling rates, and calculated Tacoma's recycling rate using Cascadia's recommended methodology combined with results of a survey of local recyclers. This summary memo is organized in to three primary sections:

- **Materials Management Metrics**
- **Municipal Solid Waste Recycling Rate Methodologies**
- **Recommended Calculation Method for Tacoma**

Materials Management Metrics

This section describes a range of potential metrics and recommends key performance indicators to guide development of the Sustainable Materials Management Plan. The potential metrics include measurement options that can help Tacoma measure progress while accounting for population growth, economic changes, new types of waste materials, and the full lifecycle impacts of material use.

Metrics are usable only when the underlying data are available. To provide context for where the City of Tacoma has complete control over data and where it will need to obtain data from private haulers and facilities, **Table 8** identifies the entities that collect each material stream by substream.

Table 8. Material Collectors by Material Stream and Substream

	Garbage	Recycling	Organics	Self-hauled materials
Single-family residential	Tacoma	Tacoma	Tacoma	Tacoma and private haulers
Multifamily residential	Tacoma	Tacoma	Tacoma	Tacoma and private haulers
Commercial	Tacoma	Tacoma and private haulers	Tacoma and private haulers	Tacoma and private haulers
Construction & demolition (C&D) debris	Tacoma	Tacoma and private haulers	Tacoma and private haulers	Tacoma and private haulers

Potential Metrics

This section identifies and assesses a range of possible metrics that account for population growth, economic changes, new types of waste materials, and—to the extent feasible—lifecycle impacts of material use. Metrics are categorized based on the type of data they require:

- Tonnage-based metrics (**Table 9**) require data only on tons by material stream and substream.

- Composition-based metrics (**Table 10**) require additional data on the composition of material, by material stream and substream.
- Access and participation-based metrics (**Table 11**) collect data on access to recycling and organics service and set-out rates.
- Environmental impact metrics (**Table 12**) require entering tonnage and composition data into specialized modeling tools.
- Waste-prevention or action-based metrics (**Table 13**) require surveying residents, businesses, or program participants or conducting other specialized studies.

Most of these metrics can also be used by an organization, such as City of Tacoma government operations, to track internal performance.

Table 9. Potential Tonnage-Based Metrics

Metric	Why Measure?	How to Measure
Total tons overall and by material stream (garbage, recycling, organics, and self-hauled) and substream (single-family, multifamily, commercial, and C&D debris)	Foundational metric on which most other metrics rely. Most metrics require having an accurate picture of total tons by stream and substream. Drawbacks: does not take into account changes in population, economy, business sectors, or underlying material stream.	Internal tracking (including measuring multifamily material separately). Reporting from private haulers, private facilities, large generators, and construction permit applicants. Ideally, account for contamination in recycling and organics.
Recycling and diversion rates by substream and for City overall	Foundational metric for comparison to Washington State as a whole and to other cities. Tacoma has set a 70 percent diversion rate target. Drawbacks: does not take into account changes in the economy, business sectors, or the underlying material stream.	Divide total tons recycled or composted by total generation. Calculate recycling rates separately from diversion rates. See *Municipal Solid Waste Recycling Rate Methodologies* Section.
Tons of garbage disposed per household, resident, employee, or unit of revenue	The disposal rate measures the results of both recycling and waste prevention while taking into account changes in population and some changes in the economy. Drawbacks: does not take into account changes in the mix of business sectors or changes in the underlying material stream.	Divide garbage tons (by residential substream or business sector) by the relevant unit of measure (such as number of households or employees).
Total generation (garbage, recycling, organics) per household, resident, employee, or unit of revenue	All material generated, even if recycled or composted, creates upstream environmental impacts. Measuring total generation rate is the first step to accounting for the full impact of waste. Even with a high recycling rate, an increasing total generation rate indicates increasing impacts. Drawbacks: does not take into account changes in the mix of business sectors or the underlying material stream.	Divide total tons generated (by residential substream or business sector) by the relevant unit measure (such as household or employee).

Metric	Why Measure?	How to Measure
Business sector-specific tons per employee per year (per unit of revenue is likely not feasible)	Changes in the mix of business sectors (such as from mainly manufacturing to mainly office-based) could affect recycling, disposal, and generation rates, masking or exaggerating the city's progress. Drawbacks: costly to measure.	Conduct generator study to measure material at the place of business and obtain estimated employees counts. (Note: this metric is costly to measure.)

Table 10. Potential Composition-Based Metrics

Metric	Why Measure?	How to Measure
Tons and percentage of materials disposed of as garbage that could have been recycled or composted by substream	Provides context for the recycling rate by measuring the remaining recycling potential—whether many or few additional tons could be recycled.	Conduct waste characterization study of garbage by substream.
Capture rates by material (such as paper)	A more precise measure of how well residents and businesses are recycling accepted material that accounts for changes in the generated material stream (such as increases in non-recyclable flexible packaging or a shift from manufacturing to office-based businesses, which generate more recyclable fiber).	Conduct material characterization study of all disposed and recycled material plus a recycling survey.
Recycling and organics contamination rates and tonnages	Contamination rates provide information on how well residents are separating recyclable and organic materials. Adjusting the recycling and organics rates for contamination presents a more accurate figure, although it may not conform to Ecology's methodology.	Request data from recycling and organics processors. Alternative: conduct material characterization study of recycling and organics streams.

Table 11. Potential Access and Participation-Based Metrics

Metric	Why Measure?	How to Measure
Number and percentage of households and businesses with recycling and organics service	Tracking the percentage of households and businesses subscribed to recycling service and (separately) organics service identifies whether the City should focus on increasing access to service. For multifamily complexes and businesses, tracking the ratio of recycling and organics service to garbage service can also identify unmet service needs. Drawbacks: having recycling or organics collection service does not equate to using the service.	Assuming that 90 percent to 95 percent of single-family residents have access to recycling and organics service, this metric should focus on multifamily and business access. Use City of Tacoma records for assessing multifamily access supplemented by a survey of businesses. Once the service percentage reaches a high threshold (such as 90 percent to 95 percent), regular tracking is not needed.
Number and percentage of households and businesses that actively recycle and compost	Tracking the percentage of households and businesses that actually use their recycling service and (separately) organics service identifies whether the City should focus on increasing use of existing service. Drawbacks: using recycling service does not equate to recycling properly (no contamination) all accepted materials.	Track the set-out rate over a reasonable period (at least 4 weeks or 3 collection cycles, whichever is longer) to record the percentage of customers setting out their recycling and organics containers for collection. (Note: data on households are typically easier to collect than data on businesses. Outside of a business sector study, it is likely not feasible to collect this information for businesses using private recyclers.)

Table 12. Potential Environmental Impact Metrics

Metric	Why Measure?	How to Measure
Greenhouse gas emissions associated with disposal, recycling, and organics	Supplements recycling rates that treat all materials the same by using greenhouse gas emissions (GHGs) to indicate the collective and differing benefits of recycling various materials. For example the GHG benefits of recycling aluminum cans is much higher than the benefits of recycling glass. Drawbacks: This metric would be calculated through the use of the Waste Reduction Model (WARM) developed by the United States Environmental Protection Agency (US EPA). WARM does not include emissions from transporting materials to export markets and is considered less accurate for organics and source reduction; GHGs are not the only environmental impact that matters and WARM's inaccuracies may lead to unintended consequences if management decisions are made solely based on WARM results.	Enter composition and quantity data for material disposed, recycled, and composted into WARM.
Lifecycle energy saved by recycling and organics	Supplements recycling rates that treat all materials the same by using embodied energy to indicate the collective and differing benefits of recycling various materials. For example the lifecycle energy benefits of recycling aluminum cans is much higher than the benefits of recycling glass. Drawbacks: methodology has not been developed yet; energy metrics may have similar drawbacks as WARM.	Once Oregon develops its methodology, adapt to use Tacoma-specific composition and quantity data for material disposed, recycled, and composted.

Metric	Why Measure?	How to Measure
Big-picture environmental impacts of end-of-life management methods (including waste prevention)	Supplements recycling rates that treat all materials the same by using environmental impact data to indicate the collective and differing benefits of recycling various materials. Attempts to indicate the collective impact of the total materials management system. Drawbacks: calculations include many assumptions about both the materials discarded and the impacts of those materials, affecting accuracy (particularly regarding waste prevention and upstream impacts); these tools require substantial effort and/or cost.	Use US EPA's Municipal Solid Waste Decision Support Tool (free but requires staff time to customize and use) or Sound Resource Management's MEBCalc™ (fee-based but the firm can conduct the customization and analysis)
Consumption-based greenhouse gas emissions inventory	Supplements downstream waste measures by estimating the upstream greenhouse gas impacts of material use. Drawbacks: calculations include many assumptions about consumption, affecting accuracy; this method requires substantial effort and/or cost.	Use the method developed by Stockholm Environment Institute for Oregon DEQ to adjust and apply Consumer Expenditure Survey data for Seattle-Tacoma-Bellevue collected by the Bureau of Labor Statistics. Oregon DEQ conducts the inventory every five years.
Consumer Environmental Index	Supplements downstream waste measures by estimating the upstream impacts of material use in multiple environmental areas. Drawbacks: calculations include many assumptions about consumption, affecting accuracy; this method requires substantial effort and/or cost.	Use the Consumer Environmental Index, developed by Sound Resource Management for Ecology.

Table 13. Potential Waste Prevention or Action-Based Metrics

Metric	Why Measure?	How to Measure
Number and percent of households or businesses who report taking a desired action	This metric is used when the City runs a general or targeted outreach and education campaign, such to promote using reusable bags or co-locate recycling bins next to all garbage bins. By measuring the number or percentage of the target audience who take the desired actions, this metric demonstrates the effectiveness of the campaign and indicates when the City can move on to target a new desired behavior.	Conduct a general survey of households or businesses or a targeted survey of participants in an outreach program. Conduct the survey before and after the campaign to measure behavior change.
Reuse based on numbers of reuse organizations, number or value of sold secondhand products, and environmental impact of reuse	If the City focuses on promoting reuse, measuring reuse can show the progress that the City's efforts support.	See "A Study of the Economic Activity of Minnesota's Reuse, Repair, and Rental Sectors" and consult with the Department of Ecology on efforts to estimate environmental impacts by applying results to the Consumer Environmental Index (CEI). An alternative method could involve surveying reuse organizations.
Amount of organics managed through backyard composting and mulch mowing	Estimates prevention of disposal of compostable material. Drawbacks: accuracy is affected by the substantial number of assumptions required to estimate figure.	Similar to Seattle, conduct a household survey to estimate the share of households that backyard compost and mulch mow. Combine survey data with waste characterization data and organics collection data on the amount of yard and food waste generated per household.

Key Performance Indicators

Cascadia recommends that the City of Tacoma tracks performance indicators in the following categories:

- Tons of generated, recycled, and disposed—in total and per unit (such as per household or per employee) for each substream (**Table 15**).
- Recycling and diversion rates—for each substream, with and without contamination if possible (**Table 16**).
- Remaining recycling potential—based on the percentage and tons of garbage that could have been recycled or composted by each substream (**Table 17**).
- Capture rate—for key recyclable and compostable materials from each substream (**Table 18**).

Key performance indicators are listed in **Table 14**, supported by additional performance indicators listed in **Table 15** through **Table 18**. All of the indicators can all be calculated using tonnage and composition data.

Table 14. Key Performance Indicators

<table>
<tr><td colspan="4">Total material (residential, commercial, and C&D debris)
• Total tons of material generated
• Total tons disposed of as garbage
• Diversion rate, adjusted for contamination</td></tr>
<tr><td colspan="3">Total residential and commercial (combined)
• Total tons of material generated
• Total tons disposed of as garbage
• Recycling rate, adjusted for contamination</td><td rowspan="2">C&D debris
• Total tons of material generated per construction-sector employee
• Diversion rate, adjusted for contamination</td></tr>
<tr><td>Single-family residential
• Total tons of material generated per household
• Capture rate for readily recyclable and compostable materials</td><td>Multifamily residential
• Total tons of material generated per household
• Capture rate for readily recyclable and compostable materials</td><td>Commercial
• Total tons of material generated per employee
• Capture rate for readily recyclable and compostable materials</td></tr>
</table>

At this time, Cascadia recommends incorporating environmental impacts by tracking greenhouse gas (GHG) emissions. At this time, the key environmental impact that all entities need to understand and be responsible for is GHG emissions. Use US EPA's WARM to estimate greenhouse gas emissions associated with waste generated, but—because of the drawbacks described in **Table 12**— do not treat the estimate as a *key performance indicator* and ensure WARM results are published only with contextual information regarding potential inaccuracies. Reconsider tracking greenhouse gas emissions as a key

performance indicator when WARM is refined to better address organics and source reduction or when a more reliable methodology becomes available.

Table 15 through **Table 18** illustrate several ways Tacoma may capture and record the performance indicators listed in **Table 14**. These tables help build a robust picture of Tacoma's progress on sustainable materials management using bottom-line tonnage figures. However, Tacoma may need additional measures to understand what is driving changes in these indicators.

Table 15. Tons Generated, Recycled, and Disposed

	Total Tons	Tons per Unit*
Single-Family Residential		
Recycling		
Organics		
Recycling + Organics		
Garbage		
TOTAL GENERATION		
Multifamily Residential		
Recycling		
Organics		
Recycling + Organics		
Garbage		
TOTAL GENERATION		
Commercial		
Recycling		
Organics		
Recycling + Organics		
Garbage		
TOTAL GENERATION		
Total (excluding C&D Debris)		
Recycling		NA
Organics		NA
Recycling + Organics		NA
Garbage		NA
TOTAL GENERATION		NA3
C&D Debris		
Recycling		NA
Organics		NA
Recycling + Organics		NA
Garbage		NA
TOTAL GENERATION		NA

Total (including C&D Debris)	
Recycling	NA
Organics	NA
Recycling + Organics	NA
Garbage	NA
TOTAL GENERATION	NA

* Unit could be residents/households or employees/revenues.

Table 16. Recycling and Diversion Rates (with and without contamination)

	Recycling Rate (ECY Method)			Diversion Rate (ECY Method)		
	Raw Rate	Contamination	Adjusted Rate	Raw Rate	Contamination	Adjusted Rate
Single-Family Residential						
Multifamily Residential						
Commercial						
Total (excluding C&D Debris)						
C&D Debris						
Total (including C&D Debris)						

Table 17. Remaining Recycling Potential

	Percent of Garbage that is		Tons of Garbage that are	
	Currently Recyclable or Compostable	Potentially Recyclable or Compostable	Currently Recyclable or Compostable	Potentially Recyclable or Compostable
Single-Family Residential				
Multifamily Residential				
Commercial				
Total (excluding C&D Debris)				
C&D Debris				
Total (including C&D Debris)				

Table 18. Capture Rates

	Traditional Recyclables						Compostable Organics				
	Paper	Plastic	Metal	Glass	Total (With Glass)	Total (Without Glass)	Yard Debris	Food Waste	Total	Recoverable C&D Debris	Total Readily Recoverable Materials
Single-Family Residential										NA	
Multifamily Residential										NA	
Commercial										NA	
Total (excluding C&D)											
C&D	NA	NA	NA	NA	NA	NA	NA	NA	NA		
Total (including C&D)											

Municipal Solid Waste Recycling Rate Methodologies

This section discusses key factors to consider when developing a recycling rate methodology, reviews specific methodologies used by other agencies and jurisdictions, and recommends a methodology for the City of Tacoma.

Key Factors in Recycling Rate Methodologies

When developing a recycling rate calculation methodology, a jurisdiction must consider four key factors to determine the universe of material generated and to define "recycling" and "diversion":

- **Which materials and which substreams are included?**
- **Are materials from both public and private haulers counted?**
- **What materials management methods are considered "recycling" or "diversion" (e.g., recycling of paper and plastics vs. energy recovery)?**
- **Are recycling residuals and contamination counted as recycling or garbage?**

Furthermore, if waste prevention is considered recycling, the jurisdiction must carefully consider how to quantify the waste prevention.

Material Streams and Substreams:

Recycling rates typically include MSW materials from the residential and commercial sectors. Methodologies vary in whether the universe of waste also includes:

- **C&D debris**
- **Industrial process and manufacturing waste**
- **Agricultural waste**
- **Medical waste**
- **Hazardous waste (other than household hazardous, which is MSW)**
- **Vehicles**
- **Other waste not defined by US EPA as MSW**

Haulers

While recycling rates should include all material generated regardless of hauler, it can be difficult for a jurisdiction to obtain data on waste it does not directly control through municipal collection, municipal facilities, or collection under a municipal contract, franchise, or other authority. As a result, jurisdictions vary in whether the universe of waste includes:

- Materials collected by private haulers (who are not under contract or regulated by the jurisdiction) and exported outside the jurisdiction's waste system
- Materials self-hauled outside the jurisdiction's waste system

Management Methods

Recycling rates typically include recycling and commercial composting or organics processing. Recycling means transforming or remanufacturing municipal solid waste into usable or marketable materials; it excludes using recyclable materials in landfills (such as for alternative daily cover), as aggregate (such as in roadbeds), or for energy recovery. For example, recycling glass containers into new containers is, by definition, recycling while using them as alternative daily cover or aggregate is not.

Methodologies vary in whether "recycling" or "diversion" includes:

- Reuse and repair
- Donation, including food donation
- Onsite composting, anaerobic digestion, or other management for diversion
- Other methods of waste prevention
- Combustion for energy recovery
- Down-cycling, such as using glass as aggregate in roadbeds
- Landfill alternative daily cover (ADC)

Residuals and Contamination

Because tonnage data are typically collected as part of collection (rather than after processing), many recycling rates don't account for residuals or contamination:

- Residuals the processor sorted out of materials that the generator recycled; the processor typically sends these materials for landfill or other final disposal.
- Contamination left in commodity bales (after processing at a material recovery facility, or MRF) or finished compost (after processing at a composting facility). Contamination in commodity bales can include recyclable materials that ended up in the wrong bale, such as flattened plastic bottles in a mixed paper bale.

Comparison of Recycling Rate Calculation Methodologies

Cascadia reviewed recycling rate calculation methodologies used by the United States Environmental Protection Agency (U.S. EPA), the Washington State Department of Ecology (Ecology), and other local Washington jurisdictions. These jurisdictions take into account only materials generated within their geographic boundaries. **Table 19** briefly summarizes how each of these jurisdictions addresses the four key factors for defining a recycling rate. Subsequent subsections present additional details on each methodology, including data sources.

Table 19. Summary of Recycling Rate Calculation Methods

Jurisdiction	Materials/Substreams	Haulers	Management Methods	Residuals and Contamination

Jurisdiction	Materials/Substreams	Haulers	Management Methods	Residuals and Contamination
US EPA	Residential, commercial, and institutional material (non-C&D).	All	Only recycling and commercial composting/organics processing	Unclear, but likely not accounted for
Washington Department of Ecology (Recycling Rate)	Residential, commercial, and institutional material (non-C&D). Excludes agricultural and industrial organics.	All (conducts annual survey)	Only recycling and commercial composting/organics processing	Residuals reported by MRFs as sent to landfill are counted as garbage. Contamination in bales is not accounted for.
Washington Department of Ecology (Diversion Rate)	Traditional residential, commercial, and institutional material. Also agricultural and industrial organics, C&D debris	All (conducts annual survey)	Recycling and commercial composting/organics processing In addition, reuse and repair, edible food recovery, energy recovery, and downcycling recyclable materials (such as using glass as aggregate rather than recycling into new bottles and jars)	Residuals reported by MRFs as sent to landfill are counted as garbage. Contamination in bales is not accounted for.
City of Seattle	Residential, commercial, and institutional material. C&D debris recycling is tracked but not counted in the overall rate	All (requires collectors and processors operating in the City to report annually for business permit)	Recycling and commercial composting/organics processing Backyard composting estimated	Residuals reported by MRFs as sent to landfill are counted as garbage. Contamination in bales is not accounted for.
Pierce County	Residential, commercial, and institutional material (non-C&D).	All (uses Ecology data)	Only recycling and commercial composting/organics processing	Residuals reported by MRFs as sent to landfill are counted as garbage. Contamination in bales is not accounted for.

Jurisdiction	Materials/Substreams	Haulers	Management Methods	Residuals and Contamination
King County	Residential, commercial, and institutional material (non-C&D).	All (based on Ecology and Seattle data, with some adjustments)	Recycling and commercial composting/organics processing	Residential contamination is estimated based on single-family recycling characterization data. Commercial residuals are excluded by using Ecology and Seattle data.
City of Olympia	Residential, commercial, and institutional material (non-C&D).	Only City-hauled material	Only recycling and commercial composting/organics processing	Not accounted for.

US Environmental Protection Agency

In 1997, the US Environmental Protection Agency (US EPA) published "Measuring Recycling: A Guide for State and Local Governments."[10] These guidelines define what materials and recycling methods should be included and excluded when calculating a recycling rate. In general, US EPA excluded materials for the following reasons:

- They are not defined as MSW in US EPA's Characterization of MSW.
- They have not historically been disposed of as MSW.
- They are regulated hazardous waste.
- They are generated from pre-consumer sources.
- They are managed using reuse and donation, repair, onsite management (e.g., backyard composting), combustion for energy recovery, or landfill alternative daily cover (ADC).

Additional details on the guidelines are presented in **Table 20**.

[10] United States Environmental Protection Agency, "Measuring Recycling: A Guide for State and Local Governments," 1997, retrieved from http://www.epa.gov/osw/conserve/tools/recmeas/download.htm.

Table 20. Summary of US EPA Guidelines

	Included	Excluded
Material sources	• Residential, commercial, and institutional wastes (most post-consumer wastes) • Tires (consumer cars and trucks) and lead-acid batteries (consumer cars, trucks, and motorcycles) • Household hazardous waste (except used motor oil) and consumer electronics	• C&D, abatement, and natural disaster debris • Waste from vehicles (except tires and batteries, as noted) • Agriculture, manufacturing, and industrial process waste (such as mill scraps, food processing waste, sawdust) • Used motor oil • Medical waste, • Combustion ash, municipal sewage, and industrial sludges • Mining, oil, gas wastes
Recycling Methods	• Recycling of post-consumer waste • Composting of post-consumer food scraps • Composting of yard debris (except from construction and demolition activities) • Recycling of household hazardous waste	• Recycling of excluded materials (including C&D debris; excluded vehicle waste; and pre-consumer, manufacturing, and industrial process waste) • Reuse, repair and other source reduction • Onsite/backyard composting, mulching, and grasscycling (mulch mowing) • Edible food donation • Combustion for energy recovery • Landfill alternative daily cover (ADC)

Note: This table provides a high-level summary and is not intended to capture all the details and nuances of US EPA's guidelines. Section 2B of Worksheet A identifies ADC as excluded from US EPA's standard recycling rate.

Washington Department of Ecology

The Washington State Department of Ecology (Ecology) states that its recycling rate methodology closely aligns with US EPA guidelines, based on reports from haulers and processors.[11] Ecology's *diversion* rate methodology includes additional materials and management methods that US EPA excludes from the standardized recycling rate. These expansions in the diversion rate include:

- Agricultural, industrial, and pre-consumer organics
- C&D debris, including asphalt, concrete, landclearing debris,
- Container glass used as aggregate (rather than recycling into new glass containers or products)[12]
- Reused and repaired clothing, household items, C&D debris, tires, and other materials
- Edible food recovery

[11] Washington Department of Ecology, "Waste 2 Resources > Solid Waste and Recycling Data > Recycling," Retrieved July 20, 2015 from http://www.ecy.wa.gov/programs/swfa/solidwastedata/recyclin.html.
[12] Glass collected separately by the City of Tacoma is currently recycled into new glass containers.

- Materials managed through energy recovery (including wood waste, yard waste, landclearing debris, tires, used oil, and other fuels)

The expanded scope of the diversion rate increases both tons diverted and tons generated.

City of Seattle

The City of Seattle's municipal solid waste (MSW) recycling rate methodology largely corresponds to Ecology's methodology. Seattle recycling rate includes an estimate of organics managed through backyard composting and mulch mowing. Seattle MSW tonnages also include some C&D debris disposed of in residential and commercial containers and at Seattle transfer stations. Seattle uses the following data sources to calculate the MSW recycling rate:[13]

- Weekly tonnage reports from contracted haulers and City of Seattle transfer stations on all residential recycling, organics, and garbage; commercial garbage; reports from processors that handle recycling and organics generated in Seattle; and all self-hauled materials delivered to Seattle transfer stations.
- Annual tonnage reports from private haulers, processors, and self-hauling generators who operate in the City of Seattle (required to obtain a City of Seattle business license).
- Waste characterization studies conducted for each substream on a four-year cycle.
- Home Organics Survey conducted every five years to estimate the percentage of residents using backyard composting and mulch mowing.

Seattle also calculates a C&D debris recycling and diversion rates, separate from the MSW recycling rate. The diversion rate includes both recycling and beneficial use, but not materials sent to landfills as alternative daily cover or industrial waste stabilizer. Seattle collects C&D debris data from the following sources:

- Monthly reports from transfer stations, "certified" mixed waste processing facilities, and intermodal facilities that handle C&D debris.
- Waste characterization studies, conducted approximately every seven years.
- Annual recycling reports from the haulers and recycling facilities (both source separated and "mixed waste") that haul or receive C&D from Seattle.

In addition, building permit applicants submit Waste Diversion Reports of quantities of materials hauled to different locations for reuse, recycling and disposal. While Seattle does not use these reports for quantitative data, they serve help ensure that materials are going to "certified" facilities for recycling.

Seattle uses its Seattle Discard Model to compares actual recycling performance to expected amounts of recycling, organics, and garbage that are projected based on factors including:

- Unemployment rate
- Housing prices
- Household size and income

[13] City of Seattle, Solid Waste Management Plan: Chapter 2 – Seattle Solid Waste Trends, 2011.

- Average and marginal collection fees
- Temperature and precipitation (which affect yard waste)

Pierce County

Pierce County uses data provided by Ecology to calculate its recycling rate. Pierce County's Solid Waste Management Plan Supplements from 2008 and 2015 do not indicate that the County makes any adjustments to Ecology-provided data.[14]

King County

King County's recycling rate methodology corresponds to Ecology's methodology. King County calculates its recycling rate using a variety of data sources.[15] Residential tonnages and recycling rates are based on reports from haulers. Commercial data are modeled using the following data sources:

- Department of Ecology recycling database (based on reports from haulers and processors).
- City of Seattle recycling database (based on reports from haulers and processors that collect recyclables and organics generated in Seattle).
- King County transfer station and landfill data.

King County begins with Ecology's recycling database to sum the tons assigned to King County and a portion of statewide tons not allocated to any county (in proportion to King County's share of the statewide population). After removing residential tons, King County compares Ecology data to Seattle data to estimate the commercial tons attributable to King County excluding Seattle.

King County also reduces the tons of metal recycling based on the assumption that approximately one-third is municipal solid waste (residential and commercial recycling) while the other two-thirds are associated with C&D debris and vehicle parts (not counted as recycling according to US EPA's methodology).

King County also calculates a separate C&D debris recycling rate based on reports from C&D debris processors and on Ecology data. King County attempts to align its methodology with the City of Seattle.

Recommended Calculation Method for Tacoma

Cascadia recommends that Tacoma calculate separate recycling and diversion rates consistent with the Washington Department of Ecology methodology for the City as a whole and for individual substreams. The five substreams are:

- Single-family residential
- Multifamily residential

[14] Pierce County Department of Public Works, Tacoma-Pierce County Solid Waste Management Plan Supplement, 2015 (page C-3).
Pierce County Department of Public Works and Utilities, "Tacoma-Pierce County Solid Waste Management Plan Supplement 2008," Appendix page 20.
[15] Phone Interview with Bill Reed, Recycling Program Analyst, King County Solid Waste Division, September 16, 2015.

- Commercial and industrial
- Self-haul
- C&D debris

Calculating substream-specific recycling and diversion rates help Tacoma identify where to target recycling efforts and will allow the City to compare its recycling rates to Ecology and Seattle's rates. Consistent with Ecology, Tacoma's recycling rate should count residuals as garbage, which will also help Tacoma assess whether additional education on contamination is needed.

The City should collect tonnage data from private haulers and processors that operate in Tacoma using one of the two methods below:

- Contracting with a trusted third-party firm to collect and aggregate the data.
- Partnering with Pierce County to collect and aggregate the data.

To measure residential, commercial, and self-haul diversion, Tacoma could also include local reuse organizations, such as Goodwill, in the survey. Cascadia also recommends that Tacoma track the performance indicators in the following categories:

- Tonnage metrics, by material stream and substream.
- Composition metrics, by material stream and substream, including capture rates and remaining recycling potential.

Calculation of Tacoma's Recycling Rate

To calculate Tacoma's recycling rate using the recommended method, Cascadia combined tonnage data provided by the City of Tacoma on waste managed by the municipal system with a survey private haulers and processors. These additional tons substantially increased the commercial and C&D debris recycling and diversion rates. In 2014, Tacoma achieved a 41 percent recycling rate (excluding C&D) for residential and commercial waste and a 55 percent recycling rate overall when C&D debris is included.

Table 21. Tacoma Recycling and Disposal Tonnages, 2014

Substream	Recycling			Disposal	Total Generation
	City Data	Survey Data	Total	Total	Total
Single-family	41,764		41,764	33,739	75,503
Multifamily	3,106		3,106	13,346	16,452
Commercial	8,282	37,207	45,489	61,620	107,109
Self-haul	9,191	234	9,425	32,934	42,359
C&D debris	365	105,393	105,758	23,339	129,097
Total citywide	**62,045**	**142,834**	**205,542**	**164,978**	**370,520**

Table 22. Tacoma Recycling Rates, 2014

Substream	Recycling Rate
Single-family	55%
Multifamily	19%
Commercial	42%
Self-haul	22%
Residential and Commercial Subtotal	41%
C&D debris	82%
Total citywide	55%

To conduct the survey, Cascadia worked with the City of Tacoma to identify 24 private haulers and processors that handle recyclables generated within the city of Tacoma and outside of Tacoma's municipal collection system. Cascadia obtained data from 12 companies on tons of commercial, self-haul, and C&D debris materials recycled. To avoid double-counting materials, the confidential survey included questions on tonnages received from and delivered to other haulers and processors. In future surveys, Tacoma should consider including reuse organizations (such as Goodwill), used cooking oil refiners, and other unusual processors to estimate more comprehensive diversion rates for municipal solid waste from the residential and commercial substreams.

Appendix 3. Recycling Potential and Lifecycle Cost Model Methodology

A core element of the Sustainable Materials Management Plan was the creation of a recycling potential assessment and a lifecycle cost model to quantify the impacts and costs of alternative programs, policies and infrastructure enhancements (options). These models, developed by Herrera, calculated diversion rates and life cycle costs of each option and combination of options from 2016 through 2048.

This Appendix summarizes the development and use of the models used by the consultant team. The purpose of the summary is to:

- Provide background information on how the diversion tonnage estimates were developed.
- Describe the cost modeling and assumptions behind the life cycle cost calculations.

The two models are described below. Estimates of the additional diversion produced from individual options at specific points in each Phase, implementation dates, ramp-up periods, maximum marginal recycling rates, and anticipated costs and revenues are presented in Appendix 4.

Recycling Potential Assessment Model

The Recycling Potential Assessment Model development process involved the three steps listed below.

1. Identify Waste Diversion Options and Targeted Materials

In total, the team considered over 100 programmatic, policy, infrastructure investment, and operational options that fall into six different categories, which are described in Section 4, Recommended Strategies:

- Waste Reduction/EPR
- Education & Outreach
- Operations & Programs
- Capital Investments
- Incentives & Rates
- Regulations

The options were qualitatively evaluated by the city and consultant team, and ultimately the highest ranking alternatives were grouped into four phases for modeling.

2. Establish Participation, Efficiency and Recovery Rates

For each option the team established participation, efficiency, and recovery rates. Participation rates indicate the percentage of a waste generator group that would engage in the desired waste diversion activity or behavior. Efficiency rates indicate the percentage of waste that the participating group would actually divert. Recovery rates for an option and its targeted waste materials are the product of participation and efficiency. Rates were based on a combination of:

- Actual results from existing Tacoma programs.
- Actual results from other jurisdictions' programs.
- Research on diversion rates for major program categories.

- Professional judgment of the Project team.

In addition, the team assigned a reasonable implementation year to each option within each phase, based on a sequence moving from voluntary education and outreach to more rigorous regulations and infrastructure investments.

Following the assignment of the implementation date, the team assigned a reasonable ramp up period, defined as the number of years required to achieve the maximum marginal recycling rate. The assignment of this period was again informed by research and current experience regarding complexity of the option; lead time required to minimize risk, engage stakeholders, or pass legislation; available budget; or a combination of all.

Appendix 4 shows the participation and efficiency rates, maximum marginal recovery rates, implementation dates and ramp up period for each of the options analyzed in the phased analysis.

3. Apply Options to Disposed Waste in Sequence of Increasing Intensity and Calculate Tonnage Diversion on Decreasing Balance of Disposed Tons

The spreadsheet model estimates the waste diversion effects of sequential implementation of options for each targeted material, substream and in total for the City. Sequential implementation means that each option's marginal recycle rate would apply to remaining tonnage after the tonnage from previously employed options have been diverted.

The model output provides the following information in order to determine the anticipated diversion rates for each substream and overall:

- Total tonnage shifted to recycling collection
- Total tonnage shifted to organics collection
- Net tonnage shifted to MRF facility
- Total additional diversion by waste class
- Total additional diversion by option type

Lifecycle Cost Model

The team developed planning level implementation costs for staff support, education, fixed operations & maintenance, and capital costs for each option based on assignment of unit costs and quantities for labor, equipment, and marketing/educational materials. Fixed O&M is estimated based on general industry standards for percentage of capital investments for structure maintenance, utilities, and facility maintenance. All labor positions use costs from the 2014 City of Tacoma government employee salary database, or from salaries provided directly from Solid Waste Management. Revenues are based on current prices for marketable commodities net of transportation expenses. Capital costs for MRF option 4 were based on data from the *Volume 3: MRF Feasibility Study*.

The team used life cycle cost analysis to evaluate the various options over the assumed life of each program or infrastructure investment. For each phase and combination of phases, the team calculated net present value by subtracting the present value of the options costs from the present value of the options revenues. The cost model used the following assumptions:

- Base Year of Analysis: 2015
- Final Year of Study Period 2048
- Discount Factor/Cost of Capital (2015) 5.00%
- Construction / Equipment Escalation 4.00%
- O&M Escalation 2.50%

In addition, a levelized cost per disposed ton is calculated for each phase or combination of phases through 2048, assuming a 20-year asset life for major investments. The net present value of cash flows for each phase and combination of phases (including direct and staffing costs for program and education activities, fixed operation and maintenance costs, capital expenditures, and revenues) was calculated from 2017 through 2048, and divided by the discounted total of waste disposed for the same period to calculate a cost per ton metric.

Appendix 4. Baseline Generation, Diversion, & Disposal Projection Methodology

Projected baseline generation, recycling, composting, disposal is current through 2028. We made the following key assumptions.

- Total disposal, recycling, and organic tons from 1992 to 2014 were from the Tacoma Solid Waste Management Overview Data Summary from 2015.
    - Disposal tons were allocated to substream using 2015 waste composition sampling data
    - Recovery tons were allocated to substream based on data from Tacoma tracking records by site and material
- Disposal projections were based on disposal rates from 1992 to 2014
- Recovery projections were based on different time periods depending on program implementation

See below for substream-specific methodologies.

Single-family

- Linear trends were identified from tons per SF household
- SF Household projections were from PSRC land use planning
- In 1998, single stream recycling was initiated. Recycling tons before 1999 were excluded from the trend analysis.
- To reflect the current organic collection infrastructure, organic tons before 2003 were excluded.

Multifamily

- Trends were based on a MF household discard rate
- MF Household projections were from PSRC land use planning.
- In 2002, MF recycling was initiated. Recycling tons before 2003 were excluded from the trend analysis.
- No MF organics collection infrastructure exists as of 2015.

Commercial

- Trends were based on a per employee discard rate
- Employee projections were from the Employment Security Dept.
- In 1998 single stream recycling was initiated. Recycling tons before 1999 were excluded from the trend analysis.
- Other commercial recycling and organics diversion was quantified from Cascadia's 2015 recycling survey data
- 2014 was first year of commercial organics collection.

Self-haul

- Residential SH trends were based on a per capita discard rate
- Commercial SH trends were based on a per employee discard rate

- The same years included for the SF recovery trends were included for the residential SH recovery streams.

C&D

- Both Residential and Commercial C&D trends were based on a per construction employee discard rate
- Construction employee projections were from the Employment Security Dept. for Peirce County. Proportion of construction employees working in Tacoma was provided by the PSRC
- C&D recovery was quantified by Cascadia's 2015 recycling survey data

Appendix 5. Diversion Options

The costs and diversion impacts of programs and initiatives listed in the table below will not necessarily cover the costs or produce the results if considered as a standalone program. Each option was considered as one element of a broader suite of programs and initiatives. This is particularly true for Phase 1 and 2 education and outreach, incentives, and regulatory programs.

Option Name	Orig. Imp. Date	Ramp Up	Orig. Ramp Down	Max Marginal Rec. Rate	Operating - Program Costs (Year 1 - 2015 $)	Fixed O&M Costs (Year 1 - 2015 $)	Capital Expenditures (2015 $)	Phase I (2028) (tons diverted)	Phase I, II (2028) (tons diverted)	Phase I, II, and III-MRF (2028) (tons diverted)	Phase I, II, and III- NO MRF (2028) (tons diverted)	Phase I, II, III-MRF, IV (2032) (tons diverted)	Phase I, II, III-NO MF, IV (2032) (tons diverted)	
Provide education and outreach targeted at reusable bag use. Provide reusable bags for low income residents.	2017	3	2020	4.95%	$12,405	$-	$ -	31	31	31	31	32	32	PHASE I (2017 - 2020)
Continue to provide education and outreach to new and existing customers.	2017	1	2018	5.00%	$ 105,053	$ 200,000	$ -	6,293	6,293	6,293	6,293	6,677	6,677	
Promote supply chain management and green procurement policies.	2017	7	2024	1.00%	$4,992	$-	$ -	364	364	364	364	391	391	
Promote thrift stores as the preferred option for discarding unwanted furniture.	2017	4	2021	3.00%	$32,690	$-	$ -	124	124	124	124	131	131	
Campaign to reduce food waste.	2017	5	2022	0.25%	$7,056	$-	$ -	24	24	24	24	25	25	
Conduct education and outreach on waste prevention and toxics reduction, including tailored outreach to multicultural communities.	2017	4	2021	2.00%	$14,501	$-	$ -	444	444	444	444	453	453	
Offer additional waste reduction and recycling in public school curriculums.	2017	5	2022	0.25%	$5,159	$-	$ -	171	171	171	171	181	181	
Support and promote strong EPR policy adoption by county or state government. For hard-to-recycle materials such as mattresses, paint, pharmaceuticals, and batteries.	2017	7	2024	0.00%	$3,485	$-	$ -	-	-	-	-	-	-	
Lobby for a statewide beverage container deposit system.	2017	7	2024	0.00%	$3,485	$-	$ -	-	-	-	-	-	-	
Create a Master Recycler / Composter program.	2017	5	2022	1.95%	$19,622	$-	$ -	382	382	382	382	390	390	
Establish program to share results of residential food and yard waste organics collection.	2017	5	2022	2.00%	$2,788	$-	$ -	197	197	197	197	201	201	

Option Name	Orig. Imp. Date	Ramp Up	Orig. Ramp Down	Max Marginal Rec. Rate	Operating - Program Costs (Year 1 - 2015 $)	Fixed O&M Costs (Year 1 - 2015 $)	Capital Expenditures (2015 $)	Phase I (2028) (tons diverted)	Phase I, II (2028) (tons diverted)	Phase I, II, and III-MRF (2028) (tons diverted)	Phase I, II, and III- NO MRF (2028) (tons diverted)	Phase I, II, III-MRF, IV (2032) (tons diverted)	Phase I, II, III-NO MF, IV (2032) (tons diverted)	
Manage events or an ongoing shop to exchange reusable HHW items.	2017	4	2021	12.50%	$7,358	$-	$ -	3	3	3	3	3	3	
Promote reuse and thrift stores.	2017	4	2021	2.00%	$10,796	$-	$ -	40	40	40	40	40	40	
Color code the signage system at TRTC for different materials, with consistent color coding in any print or online information or collateral.	2017	2	2019	2.50%	$7,442	$-	$ -	444	444	444	444	468	468	
Conduct periodic Knock & Talk campaigns to multifamily residents.	2017	3	2020	1.50%	$18,296	$-	$ -	118	118	118	118	123	123	
Conduct periodic Knock & Talk campaigns to commercial customers.	2017	3	2020	1.50%	$5,921	$-	$ -	530	530	530	530	569	569	
Conduct targeted education and outreach to increase quantity and quality of food waste collected.	2017	3	2020	5.00%	$98,400	$ 100,000	$ -	878	878	878	878	943	943	
Expand commercial technical assistance.	2017	5	2022	2.50%	$78,334	$-	$ -	1,062	1,062	1,062	1,062	1,141	1,141	
Promote and facilitate pre-consumer food donations by food service businesses.	2017	4	2021	0.75%	$13,472	$-	$ -	122	122	122	122	131	131	
Promote C&D debris salvage, reuse, recycling, and exchange to construction professionals	2017	4	2021	7.50%	$27,968	$-	$ -	198	198	198	198	218	218	
Promote C&D debris salvage, reuse, recycling, and exchange to residents.	2017	5	2022	6.00%	$30,864	$-	$ -	938	938	938	938	1,014	1,014	
Promote green building practices to commercial C&D customers.	2017	5	2022	7.50%	$27,968	$-	$ -	176	176	176	176	194	194	
Promote green building practices to self-haul C&D customers.	2017	5	2022	3.00%	$30,864	$-	$ -	421	421	421	421	455	455	
Promote onsite organics processing at food-generating businesses.	2017	5	2022	1.60%	$11,046	$-	$ -	258	258	258	258	278	278	
Promote recycling drop-off opportunities.	2017	3	2020	2.50%	$4,996	$-	$ -	314	314	314	314	331	331	
Promote use of e-waste recycling drop-off locations.	2017	3	2020	10.00%	$4,996	$-	$ -	45	45	45	45	47	47	
Provide education and outreach targeted at multifamily property managers and tenants to increase recycling and composting.	2017	5	2022	10.00%	$75,146	$-	$ -	763	763	763	763	796	796	

Option Name	Orig. Imp. Date	Ramp Up	Orig. Ramp Down	Max Marginal Rec. Rate	Operating - Program Costs (Year 1 - 2015 $)	Fixed O&M Costs (Year 1 - 2015 $)	Capital Expenditures (2015 $)	Phase I (2028) (tons diverted)	Phase I, II (2028) (tons diverted)	Phase I, II, and III-MRF (2028) (tons diverted)	Phase I, II, and III- NO MRF (2028) (tons diverted)	Phase I, II, III-MRF, IV (2032) (tons diverted)	Phase I, II, III-NO MF, IV (2032) (tons diverted)	
Review and update all existing outreach messages to ensure the recycling target/zero waste goals are highly visible. Include recycling guides, welcome packets.	2017	5	2022	3.25%	$13,728	$-	$ -	798	798	798	798	840	840	
Establish a voluntary initiative for disposable plastic grocery bag take-back program.	2017	3	2020	25.00%	$14,853	$-	$ -	138	138	138	138	143	143	
Adopt a sustainable purchasing policy and develop tools and systems to increase green purchasing by City departments.	2019	3	2022	0.00%	$20,646	$-	$ -	-	-	-	-	-	-	
Ensure that all MF sites have adequate recycling and organics collection infrastructure.	2019	5	2024	5.00%	$ 110,263	$-	$191,250	344	344	344	344	359	359	
Expand food waste collection program to accept compostable paper and food serviceware. (private haulers)	2019	4	2023	4.00%	$ 110,755	$-	$208,500	875	875	875	875	940	940	
Expand public space recycling.	2019	5	2024	0.00%	$10,759	$ 17,500	$175,000	-	-	-	-	-	-	
Support reusable transport packaging program.	2019	5	2024	2.00%	$15,929	$-	$ -	111	111	111	111	119	119	
Promote and incentivize the use of Residential food grinders. Could include rate incentives similar to KC Surface Water.	2019	5	2024	12.50%	$24,160	$ 112,500	$375,000	1,132	1,132	1,132	1,132	1,154	1,154	
Provide financial incentives to self-haul customers increase diversion of materials at TRTC.	2019	3	2022	10.00%	$ -	$-	$ -	1,053	1,053	1,053	1,053	1,109	1,109	
Provide financial incentives to self-haul C&D customers increase diversion of materials at TRTC.	2019	3	2022	10.00%	$21,059	$-	$ -	947	947	947	947	1,024	1,024	
Enforce state regulations such as the "two-bin rule."	2020	3	2023	15.00%	$34,205	$-	$ -	409	409	409	409	451	451	
Require new commercial buildings to have adequate recycling and composting space/enclosures to receive building permit.	2020	4	2024	4.25%	$19,665	$-	$ -	1,421	1,421	1,421	1,421	1,527	1,527	
Require owners and contractors to use Certified C&D Processing Facilities.	2020	1	2021	64.00%	$78,198	$-	$ -	1,250	1,250	1,250	1,250	1,379	1,379	

Option Name	Orig. Imp. Date	Ramp Up	Orig. Ramp Down	Max Marginal Rec. Rate	Operating - Program Costs (Year 1 - 2015 $)	Fixed O&M Costs (Year 1 - 2015 $)	Capital Expenditures (2015 $)	Phase I (2028) (tons diverted)	Phase I, II (2028) (tons diverted)	Phase I, II, and III-MRF (2028) (tons diverted)	Phase I, II, and III- NO MRF (2028) (tons diverted)	Phase I, II, III-MRF, IV (2032) (tons diverted)	Phase I, II, III-NO MF, IV (2032) (tons diverted)	
Establish recurring drop-off event for reuseables - "Use it Again, Tacoma."	2021	3	2024	0.75%	$32,690	$-	$ -		51	51	51	53	53	PHASE II (2021 - 2022)
Enhance floor sorts for bulky reusable and recyclable items at TRTC.	2021	2	2023	15.00%	$3,013	$ 80,000	$ -		2,208	2,208	2,208	2,326	2,326	
Enhance floor sorts for bulky reusable and recyclable items at TRTC.	2021	2	2023	40.00%	$ -	$ 261,145	$170,000		4,223	4,223	4,223	4,563	4,563	
Expand materials accepted in curbside recycling to include textiles, additional types of scrap metal, or plastics.	2021	5	2026	48.00%	$35,326	$-	$ -		1,106	1,106	1,106	1,129	1,129	
Increase Pay-As-You-Throw rate differentials.	2021	3	2024	10.00%	$47,593	$ 7,500	$25,000		1,439	1,439	1,439	1,468	1,468	
A - Expand mixed organics processing capacity, and expand collection to accommodate compostable paper and food serviceware.	2021	3	2051	12.50%	$21,929	$-	$5,435,700		5,753	5,753	5,753	6,073	6,073	
Enforce state regulations such as the "two-bin rule."	2021	3	2024	5.00%	$34,205	$-	$ -		483	483	483	522	522	
Prohibit disposal of recoverable C&D materials for commercial C&D customers.	2021	5	2026	64.00%	$29,077	$-	$ -		527	527	527	581	581	
Prohibit disposal of recoverable C&D materials for self-haul C&D customers.	2021	5	2026	64.00%	$30,864	$-	$ -		5,817	5,817	5,817	6,286	6,286	
Ban retail disposable plastic bags (with some exemptions) and establish fee on paper bags.	2021	3	2024	76.50%	$14,853	$-	$ -		387	387	387	403	403	
Require multifamily property owners/managers to provide adequate recycling collection service for residents (establishing a "right to recycle").	2022	4	2026	10.00%	$33,018	$-	$ -		927	927	927	967	967	
Require new buildings to have adequate space and facilities for recycling and organics storage and collection.	2022	4	2026	8.50%	$29,361	$-	$ -		433	433	433	451	451	
Require recycling of C&D Materials at all job sites.	2022	4	2026	54.00%	$34,205	$-	$ -		181	181	181	200	200	
Require recycling at all job sites.	2022	5	2027	27.00%	$30,864	$-	$ -		876	876	876	946	946	
Require self-haul customers to separate recyclables at TRTC.	2022	5	2027	40.00%	$13,890	$ 68,921	$ -		6,526	6,526	6,526	6,874	6,874	
Require self-haul C&D customers to separate recyclables at TRTC.	2022	5	2027	40.00%	$13,890	$ 68,921	$ -		843	843	843	911	911	

Option Name	Orig. Imp. Date	Ramp Up	Orig. Ramp Down	Max Marginal Rec. Rate	Operating - Program Costs (Year 1 - 2015 $)	Fixed O&M Costs (Year 1 - 2015 $)	Capital Expenditures (2015 $)	Phase I (2028) (tons diverted)	Phase I, II (2028) (tons diverted)	Phase I, II, and III-MRF (2028) (tons diverted)	Phase I, II, and III- NO MRF (2028) (tons diverted)	Phase I, II, III-MRF, IV (2032) (tons diverted)	Phase I, II, III-NO MF, IV (2032) (tons diverted)	
Design routes to collect highly recoverable waste for processing at a MRF.	2023	2	2025	18.00%	$22,700	$-	$ -			2,786	-	2,992	-	A
Ban wood at TRTC.	2023	2	2025	81.00%	$13,890	$ 68,921	$ -			2,395	-	2,530	-	
Invest in or contract for a new MRF focused on Commingled SF Residential Recyclables and mixed waste processing for Select High-Grade Non-C&D Commercial Waste and High-grade non-C&D self-haul waste (MRF #4)	2023	7	2053	81.00%	$ -	$4,758,000	$33,000,000			25,020	-	26,760	-	
Implement intensive award and recognition programs for businesses.	2023	5	2028	0.50%	$12,273	$-	$ -				179	-	192	B
Hold neighborhood swap and repair events.	2023	3	2026	1.25%	$35,632	$-	$ -				17	-	17	
Authorize mandatory recycling laws for targeted materials.	2023	4	2027	68.00%	$16,576	$-	$ -				8,214	-	8,380	
Require businesses with outdoor garbage bins for public use to provide adjacent recycling containers.	2024	3	2027	0.00%	$14,075	$-	$ -				-	-	-	
Require commercial property owners and businesses to provide recycling collection service (subscription or self-haul).	2024	5	2029	4.00%	$27,092	$-	$ -				563	-	605	
Require food service establishments to use recyclable and/or compostable food serviceware.	2025	4	2029	17.10%	$13,984	$-	$ -				3,053	-	3,280	
Require large events on public property to recycle and compost.	2024	3	2027	0.00%	$14,075	$-	$ -				-	-	-	
Require single-family residents to subscribe to curbside recyclables and organics collection.	2025	4	2029	5.00%	$12,709	$-	$ -				-	-	207	
Require composting for Organic materials	2028	4	2032	48.00%	$51,382	$-	$ -				-	10,490	11,269	PHASE IV (2028 -2030)
Require recycling for Traditional Recyclables	2028	4	2032	64.00%	$55,154	$-	$ -				-	3,539	10,781	
Co-locate recycled-content product manufacturer at TRTC.	2030	6	2060	32.00%	$15,066	$-	$1,799,000				-	824	881	

Option Name	Orig. Imp. Date	Ramp Up	Orig. Ramp Down	Max Marginal Rec. Rate	Operating - Program Costs (Year 1 - 2015 $)	Fixed O&M Costs (Year 1 - 2015 $)	Capital Expenditures (2015 $)	Phase I (2028) (tons diverted)	Phase I, II (2028) (tons diverted)	Phase I, II, and III-MRF (2028) (tons diverted)	Phase I, II, and III- NO MRF (2028) (tons diverted)	Phase I, II, III-MRF, IV (2032) (tons diverted)	Phase I, II, III-NO MF, IV (2032) (tons diverted)	
Include a retail salvage building materials reuse center at TRTC.	2029	3	2049	9.00%	$ -	$ 203,499	$2,406,250				-	88	104	
Include a retail thrift store, reuse and recycling center at TRTC.	2029	3	2049	12.50%	$ -	$ 232,002	$4,686,500				-	259	259	

Appendix 6. Tacoma Compost Facility Options (60,000 tons per year)

Description

Currently, the City collects almost 30,000 tons of organic materials. This includes vegetative and other source separated food waste and yard waste collected from mostly residential customers. The City is considering implementing new programs and services aimed at recovering an additional 25,000 to 30,000 tons of organics from both residential and commercial customers.

Based on estimates made by the Cascadia consulting team in conjunction with the City, new programs could result in collecting 51,000 tons of various organic waste streams by 2020. By 2028, it is projected that almost 60,000 tons of organic materials could be recovered for processing. The organic waste stream is comprised of three primary material types; food waste; compostable paper; and, yard waste which include grass, brush, yard trimmings and woody debris. The estimates are shown in **Table 1**.

Table 1 – Estimated Quantity of Organics

Available Organics (tons per year, tpy)	2020	2028	2028 (tons per day, tpd)
Food Waste	31,250	34,337	132
Compostable Paper	8,778	9,760	38
Yard Waste	11,736	13,048	50
Total Estimated Recovered Organics	**51,764**	**57,145**	**220**

For this analysis it is assumed the materials will delivered to a central processing and composting facility. The exact nature and composition of these different organic waste streams may vary depending on the collection services that are provided. For instance, it is expected that source separated yard waste currently collected will contain food waste from residential customers. As a result it will also contain a certain percentage of compostable paper. Commercial food waste may be collected separately or the mixed organics may be recovered from a MRF.

The new programs and services may generate an estimated 60,000 tpy of mixed organics or 230 tons per day by 2028. Assuming the compost facility will be located in somewhat urbanized setting, the compost facility will need enclosed buildings to receive and process materials. Also, the technology used will require a combination of enclosed and partially enclosed structures and employ technology that can convert the materials into a usable product in lesser time. The options discussed in the following sections represent technologies to convert organics to usable soil amendment products in less than 50 days. These technologies are also scalable so additional units can be constructed to increase capacity. The site must also provide space to cure and temporarily store composted materials.

Receiving and Pre- Processing

To handle 230 tpd of mixed organics it is expected an enclosed receiving building will be required. This is due the fact that certain organics will need to be processed to remove contaminants. The equipment line is expected to handle 40 tons per hour (tphr) requiring up to 6 hours for processing. The receiving building should be sized to handle surges and temporarily store materials when not processing. It may be possible that some of the materials such as those with high amounts of yard waste and less food waste, could be unloaded outdoors if they are processed and place in the compost units on a continuous basis.

To remove the primary contaminants it is assumed some level of pre-processing will be needed. This system will vary depending on the characteristics of the materials being delivered. For the purpose of developing a planning level cost estimate the pre-processing system will include the following:

1. In feed conveyor
2. A screen or trommel to screen fines (2" to 4") from large items mostly plastics and larger fiber
3. Sort Line (Manual sorting) to remove larger plastics, metal and other larger items. Depending on the degree of contamination air density separation and optic sorters could also be used. These were not included in the estimated capital cost.

The larger items removed is expected to be landfilled but would most likely contain high BTU by products that could have energy value.

It is expected that organics materials delivered from the MRF will be largely glass free as the system is assumed to have a state of the art glass recovery system. However, if glass is contained in food waste collected from the commercial routes delivered directly to the compost site, the by-products will need further processing to remove glass and other contaminants in order to meet markets specifications. These costs are not included in the process equipment.

Compost Systems

The compost technology to be employed at the facility can vary greatly from simple aerated windrow to a total in vessel system that is fully enclosed. It is expected the facility might be located at the closed landfill site or a site near the City. With this assumption the system will be use a technology ranging from moderate cost for a Aerated Static Pile system to one that use a Stationary In vessel system at a higher cost. This approach uses up less land and provides greater control of odors and storm water runoff.

Option 1- In Vessel w/ Aerated Static Pile (High Tech)

This approach uses a stationary in vessel system fully enclosed as the primary composting operation. Materials are loaded into the vessel that are fully enclosed and provide an air and temperature control system to compost materials for 18 days. Once completed the materials are moved to a secondary aerated static pile bunker system to finish out the compost process for 22 days. The systems include bio-filter to treat the exhaust air.

The estimated cost of the system is based on the previous estimates provided by Engineered Compost Systems and extrapolated for the larger system to handle 60,000 tpy.

Option 2 – Aerated Static Piles system

This system uses an enhanced Aerated Static Pile system to perform the primary compost estimated to be about 20 to 25 days. The cost of this aerated static pile system in the primary phase is higher because it uses stainless steel ducting and pipes and there are larger motors capable of moving air in both the positive and negative direction. The material is removed and placed in secondary aerated static piles, similar to Option 1, to complete the compost process for another 22 days. Although the system includes a bio filter the Aerated Static Piles in the primary phase is not fully enclosed.

Both systems can be constructed on a 10 acre site assuming the site is relatively flat and is rectangular in shape. The entrance roads and receiving building as assumed to be constructed on 3 acres and the compost units will require another 2 acres. The remaining 5 acres are to be used for curing and product storage for as much as 150 days.

Cost of Compost Systems

The Capital Construction Cost estimates were prepared to be used to compare the cost of recovering and processing organics from the mixed waste stream to other management programs on a programmatic/ planning level. Further refinement of these cost estimates should be made if the City decides to pursue these options and as more detailed information of specific alternatives becomes available.

Option 1- Stationary In-Vessel w/Aerated Static Pile (AEP)	$ 19.0 M
Option 2 – Aerated Static Pile for primary and secondary processing	$ 14.0 M

See attached spreadsheets

Both of the cost estimates include $3.5M to construct a 20,000 sf receiving building, install equipment to process material and provide mobile equipment such as loaders and containers. The process equipment is relatively a low tech necessary to remove small quantities of contaminants.

It is possible to lower the capital cost by constructing an aerated windrow system either covered or uncovered. However, these operations are usually located in rural areas with few neighbors that would not be subject to odors. This approach would also require more land perhaps an additional 5 acres or more.

One other consideration is to construct a Dry Fermentation Anaerobic Digester (AD) system in place of the in-vessel compost unit. The AD units are similar to the in vessel but include a tank to collect and store percolate and a gas storage unit. The benefit of constructing the AD will be to recover the methane gas that can be used to generate electricity or be converted to compressed natural gas (CNG). Once the initial process is complete, usually in about 20 days, the digestate can be removed and

processed in contained bunkers with bio – filters to remove obnoxious odors, usually between 4- 8 days. The material can be further cured in windrows or static piles. By investing additional capital in the AD system allows the City to produce both renewable energy and compost

Operating Cost

The cost to operate the compost systems as described is estimated to be $17 to $25 per ton. This is similar to that of operating the system with 30,000 tpy due to the fact the fixed operating costs are similar. Handling the large volume may require some additional labor to handle materials.

Note: Engineered Compost Systems (ECS) of Seattle, a designer/developer of compost systems of various technologies provided information related to the technology and the construction cost for these systems.

Tacoma Compost Facility

Option 1 - In - Vessel Concept Plan - Construction Cost Estimate

Assumptions ***60,000 TPY*** ***230 TPD @ 52 Wks. @5 days /Wk.***

Description	Quantity	Unit	Unit Cost	Total Cost	Comment
Site Work - Estimate 10 acre Site					
Site Clearing & Grading	450,000	SF	$0.50	$225,000	Site is relatively Flat
Site access roads	30,000	SF	$5.00	$150,000	1000 Lin ft. @ 20' + maneuvering areas
Utilities /Electrical	1	Unit	$500,000.00	$500,000	Allowance - Water is within 500 ft of site
Subtotal Site work				**$875,000**	
Buildings & Structures					
Primary Units					
Stationary In- vessel (ECS SV Composter)	1	Unit	NA	$6,500,000	Capacity 230 tpd @365 days per year
SV uses 40,000 SF 18 days					Note- some economies of scale might be achieved in final engineering and design
Secondary					
Aerated Static Piles / Bunkers (ECS ASP)	1	Unit	NA	$3,000,000	Capacity 230 tpd
ASP uses 30,000 SF					Note- some economies of scale might be achieved in final engineering and design
Bio filter	6,000	SF	NA	Included	Included in Compost Unit Cost
Subtotal Buildings and Structures				**$9,500,000**	
Product Storage Area					
Paved Storage	150,000	SF	$4.50	$675,000	Asphalt paved with drainage -150 days
Storm water w/treatment	400,000	1	unit	$400,000	Water recirculation w/ treatment approaches may reduce water supply expenses
Support Buildings and Equipment					
Receiving Building	20,000	SF	$130.00	$2,600,000	Assume - Mixed organics delivered will need to be temporarily stored an processed in enclosed space
Pre-Processing / Clean Up Screening	1	Unit	NA	$500,000	Allowance Screening / conveyors
On site mobile equipment (2 Loaders + containers etc.)	1	Unit	$500,000.00	$500,000	
Subtotal Equipment and Storage Area				**$4,675,000**	
Compost Facility				**$15,050,000**	
Contingency			@ 15%	**$2,257,500**	
Engineering			@ 10%	**$1,505,000**	
Total for Option 1 In -Vessel				**$18,812,500**	**USE $19 M**

Preliminary Cost Estimates for Compost Technology are based on information Provided by ECS - (Engineered Compost Systems)

Planning Level Cost estimates carry +15% / - 15% level of accuracy

All prices are presented in 2016 dollars.

Siting and permitting cost and cost of land not included **9/15/2016**

No marketing and product transportation costs are included

Tacoma Compost Facility

Option 2 - Aerated Static Pile Concept Plan - Construction Cost Estimate

Assumptions ***60,000 TPY*** ***230 TPD @ 52 Wks. @5 days /Wk.***

Description	Quantity	Unit	Unit Cost	Total Cost	Comment
Site Work - Estimate 10 acre Site					
Site Clearing & Grading	450,000	SF	$0.50	$225,000	Site is relatively Flat
Site access roads	30,000	SF	$5.00	$150,000	1000 Lin ft. @ 20' + maneuvering areas
Utilities /Electrical	1	Unit	$500,000.00	$500,000	Allowance - Water is within 500 ft of site
Subtotal Site work				**$875,000**	
Buildings & Structures					
Primary Units					
Aerated Static Pile Units (ECS Primary ASP Composter)	1	Unit	NA	$4,000,000	Capacity 230 tpd @365 days per year
Primary ASP uses 40,000 SF for 22 days					Note- some economies of scale might be achieved in final engineering and design
Secondary					
Aerated Static Piles / Bunkers (ECS ASP)	1	Unit	NA	$1,500,000	Capacity 230 tpd
ASP uses 30,000 SF for 22 days					Note- some economies of scale might be achieved in final engineering and design
Bio filter	6,000	Unit	NA	Included	Included in Compost Unit Cost
Subtotal Buildings and Structures				**$5,500,000**	
Product Storage Area					
Paved Storage	150,000	SF	$4.50	$675,000	Asphalt paved with drainage -150 days
Storm water w/treatment	400,000	1	unit	$400,000	Water recirculation w/ treatment approaches may reduce water supply expenses
Support Buildings and Equipment					
Receiving Building	20,000	SF	$130.00	$2,600,000	Assume - Mixed organics delivered will need to be temporarily stored an processed in enclosed space
Pre-Processing / Clean Up Screening	1	Unit	NA	$400,000	Allowance Screening / conveyors
On site mobile equipment (2 Loaders + containers etc.)	1	Unit	$500,000.00	$500,000	
Subtotal Equipment and Storage Area				**$4,575,000**	
Compost Facility				**$10,950,000**	
Contingency			@ 15%	**$1,642,500**	
Engineering			@ 10%	**$1,095,000**	
Total for Option 1 In -Vessel				**$13,687,500**	**USE $14 M**

Preliminary Cost Estimates for Compost Technology are based on information Provided by ECS - (Engineered Compost Systems)

Planning Level Cost estimates carry +15% / - 15% level of accuracy

All prices are presented in 2016 dollars.

Siting and permitting cost and cost of land not included **9/15/2016**

No marketing and product transportation costs are included